POWER

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The Value of Acquaintance

IN ANY group, in any society, in any activity, the man who dominates, the man who can point his conversation with living examples, the man who can command the largest resources, cuts the widest swath and lives the biggest, fullest and most useful life and gets the most out of living, is the man with the largest circle of friends.

He cannot make them by staying at home and reading even the best of books, or playing pinochle or Mah Jong, or listening to the radio.

He must have the qualities that attract and please and interest and hold people. And he must have enough interest in people to learn who and what they are, what they have done and what their minds are occupied about and their time spent upon.

The way to have a friend is to be a friend.

Do not think from the foregoing that I advise the hunting of friends for the use that they may be to one.

The man who seeks friends with any such ulterior purpose in mind, without the sincerity and good fellowship and thoughtfulness for others that make association with him to be desired, will find his friends dropping from one end of the string as fast as he adds them to the other.

And while I should deplore any sordid motive of self interest in discussing the value of friendship, the discussion would be incomplete without remarking that it is a good deal easier for Opportunity to knock at one's door if she has the advantage of a large number of friendly hands with which to do the knocking.

F. R. Low

Power Plant of the Detroit Lubricator Company

By C. K. LITTLE*

THE new power plant of the Detroit Lubricator Company, Detroit, Mich., is undoubtedly one of the forerunners of that general type of isolated industrial heating plant destined to replace the old haphazard designs which are responsible for the largest part of our annual coal wastage.

With two boilers of only 2,360 sq.ft. of heating surface each, the plant was designed with the care and foresight used on a central station. The building itself was erected in the latter part of 1922 at a cost of $26,000, including the inside coal-storage bunker and the company's experimental laboratory on the second floor above the compressor room. No excavation was made except for building foundations and for the pump sump. The over-all cost of the project, including building, equipment, stack, coal-handling and storage equipment and the laboratory, was approximately $60,000. A portion of the cost is, of course, chargeable to the laboratory, and not to the power plant proper. The cost of the several sections of the work are given in the table.

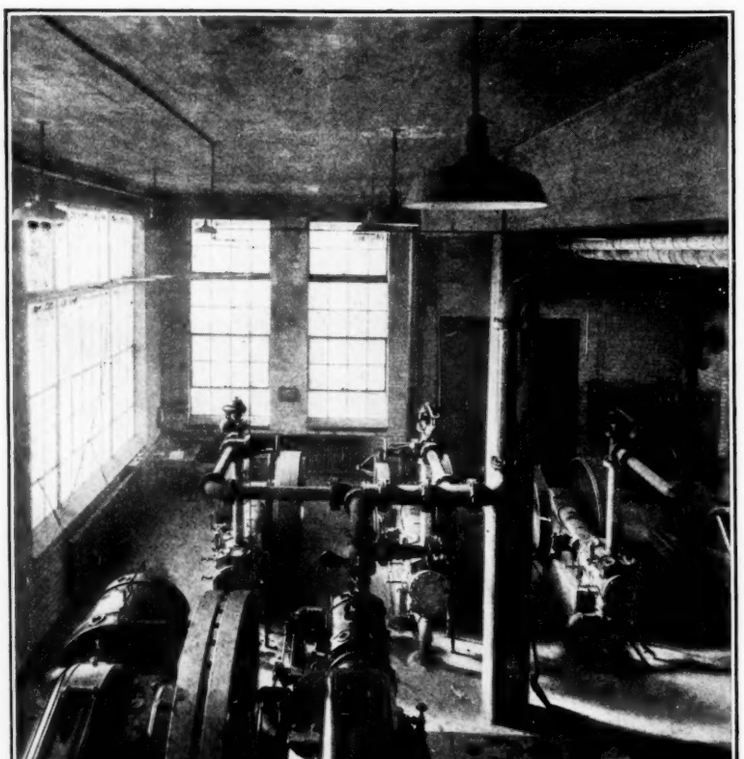

Fig. 1—Compressor room, Detroit Lubricator Company

The boilers are on the second floor of the building, with the inside coal storage directly above the stokers. The coal bunker, Fig. 4, is of sheet steel, reinforced with angles and supported from the boiler columns and the building wall, the latter dividing the boiler room from the compressor room. Directly beneath the boiler room on the ground floor is the ash alley, Fig. 2.

Two bent-tube boilers with 2,360 sq.ft. of heating surface each, are set in battery, either boiler being able to carry the entire plant load during the coldest weather. Each boiler is fired by a gravity underfeed stoker having 47.7 sq.ft. of projected grate area. This gives a ratio of 49.4 sq.ft. of boiler surface to each sq.ft. of projected grate area. The most economical point of boiler operation is at from 100 to 150 per cent of nominal boiler rating, but a possible continuous operation at 250 per cent of nominal rating and a maximum steam production of 275 per cent for periods of four hours is possible, if it should become necessary.

That part of the stokers outside the furnace is of standard central-station design, while the inside sections have been shortened to seventeen tuyeres in order to keep down the grate surface and cause the most economical point of boiler operation to be in the neighborhood of the average load; that is, about 125 per cent rating. The periodic type of dump grates is used rather than the continuous discharge, owing to the limited size of the installation. The dump grates are operated by steam cylinders and can be raised above their normal resting level to break up any clinker formations adhering to the bridge wall or to the rear part of the stoker.

The boilers are fed by one 8x5x12 duplex boiler-feed pump, supplemented by a 2-in. injector installed on each boiler for emergency.

In that part of the building not used for steam generation, the ground floor is devoted to pumps, compressors, etc. The main compressor is a duplex steam-driven unit rated at 152 indicated horsepower and has cross-compound two-stage air cylinders rated at 888 cu.ft. per min. piston displacement. This compressor was installed in order that the boilers might be run at an economical rating during the summer months, as steam is required the year around at 125 lb. pressure for testing valves, lubricators and other steam specialties manufactured by this company. When there is no heating load, the exhaust from this main compressor is turned into an open feed-water heater.

During the heating season the steam end of the compressor is used as a reducing valve between the

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boilers and the heating system, and supplies sufficient steam for 40,000 sq.ft. of radiation in the late spring and early fall. When cold weather comes on, additional steam is fed into the heating system through a reducing valve from the main steam header. Water returns from the heating system at about 180 deg. F.

There are, in addition, four belt-driven single-stage air compressors, each of which is rated at 324 cu.ft. per min. and is driven by a 50-hp. slip-ring induction motor. The remaining unit has a rated capacity of 265 cubic feet.

Cooling Water Supply

Air is discharged at 82 lb. gage pressure into a vertical aftercooler. The discharged air from the compressor begins to lose the heat acquired by compression immediately after it leaves the compressor cylinders, and the moisture in it is condensed and precipitated in the air line and aftercooler. The cooling water for the compression and coolers is obtained by tapping the 50,000-gal. fire-service tank at a point about one foot from the top. This water feeds by gravity to the cooling-water jackets and drains into a common sump, from which it is pumped back into the fire-service tank by a double-suction, single-stage centrifugal pump direct-connected to a 7½-hp. squirrel-cage motor. This pump is rated at 100 gal. per min. against a total head of 120 ft. when running at a speed of 1,750 r.p.m. The motor is equipped with automatic starter and float control.

The big advantage of such an installation is not only the saving that can be effected in the water bill, but also the elimination of steam coils in the sprinkler tank to prevent freezing in cold weather.

The manufacturer of the coal-handling equipment had to plan a coal-handling and storage system that could be placed in an area about 35 feet square, and an original design was developed to meet this condition and still give an inexpensive yet practical unit.

The system consists of two circular tile-block storage tanks, Fig. 3, having a capacity of 1,000 tons of coal, or a reserve supply sufficient for 60 days. Coal is brought in railroad cars to the company's siding and dropped into a hopper beneath the track, from which it is fed directly through controlling gates into a skip-hoist bucket. The skip-hoist elevates the coal to a receiving hopper above the tanks, from which it may be spouted into either of the two storage tanks or into the steel bunker directly over the stokers in the boiler room. Direct feed to the stoker hoppers is obtained from the inside bunker by gravity down an inclined chute.

In order to reclaim all storage coal by gravity, each of the tile-block storage tanks drops its coal through chutes directly back into the skip-hoist so that it may be elevated and spouted by gravity into the boiler-room bunker. The entire storage and elevating equipment occupies a ground space of approximately 1,000 sq.ft., giving about one ton of storage capacity for each square foot of ground space. With the service of one operator, the equipment has a capacity to handle 30 tons of coal per hour, either when unloading from the cars or when reclaiming from the tanks. Owing to the simplicity of the equipment an inexperienced operator can handle it successfully.

Ashes are dumped from the stokers once or twice a day, depending on the rate of firing. Concrete ash hoppers, Fig. 2, provide sufficient ash storage for 24 hours.

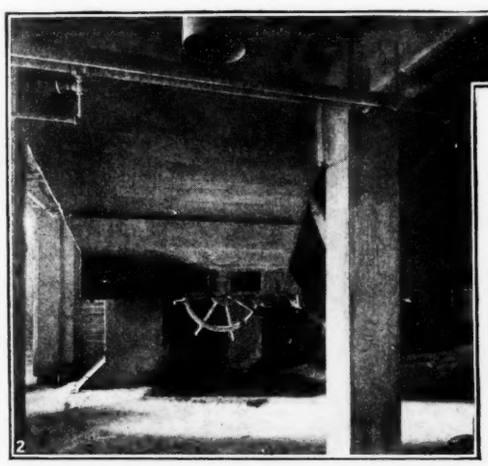

Fig. 2—Concrete ash hopper and gate

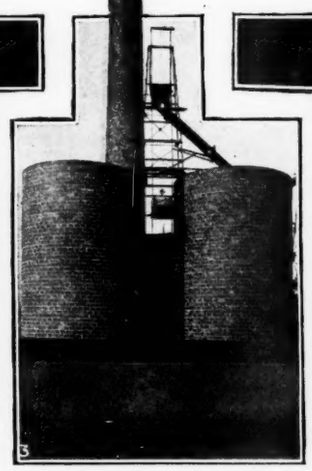

Fig. 3—Tile coal hoppers

Fig. 4—View of coal bunker and stoker

While the ash hoppers are of concrete, the ash-gates themselves as well as frames, rollers, etc., are of cast iron to resist corrosion. An electric tilting-hopper truck is run beneath the ash gates when the ashes are to be removed. This same truck is employed in yard work for conveying raw material about the grounds, so that no additional equipment is required for ash disposal.

COST OF MACHINERY, DETROIT LUBRICATOR POWER PLANT

Item	Cost	Cost per Sq.Ft. of Boiler-Heating Surface	Remarks
Building	$26,000	$3.50	Includes all labor and material for construction of building, foundations and inside coal-storage bunker
Boilers	17,000	3.60	Includes erection and brickwork
Stokers	8,300	1.20	Includes stoker driving engine, fan, air ducts and automatic regulation, and erection expense
Auxiliary equipment	2,600	6.00	Includes piping, ash hoppers, instruments and all boiler-room accessories
Compressors	6,100	....	Includes cost of new compressor and moving of old compressors
Total	60,000		

The power-plant force consists of one engineer, one day fireman and one night fireman. Coal handling, requiring about one hour, and ash handling, requiring about 15 minutes per day, are taken care of by the yard men.

Auxiliary Equipment for Blast and Ventilating Fans

Methods of Supporting Fan and Drive to Meet Various Conditions—Preventing Vibration —Air Velocities—Engine and Turbine Drives—Direct and Alternating-Current Motor Drives—Speed Regulation with Motor Drive

BY CHARLES L. HUBBARD*

FANS of different kinds form a part of the equipment in many power and heating plants, and to get the best results from these under varying conditions of operation it is important that they be properly installed and furnished with the form of drive best suited to the special requirements in each individual case.

FOUNDATIONS AND SUPPORTS

The foundations and supports must not only be of sufficient size and strength to support the fan and its driving mechanism, but must be so constructed as to reduce vibration to a minimum in many kinds of buildings. Fans of small and medium size, operated at moderate speeds, do not require special foundations in many cases when placed in basements having heavy concrete floors. In cases of this kind anchor-bolts embedded in the concrete when it is laid are all that is required. These should be of sufficient length to extend through a wooden sill three or four inches in thickness, to which the fan base may be attached by lag screws. If, in any case, it is desired to eliminate all wood in construction of this kind, the fan base may be bolted directly to the floor and a solid bearing secured by grouting.

The wooden sill requires less care in locating the anchor bolts and also serves, to some extent, as a cushion

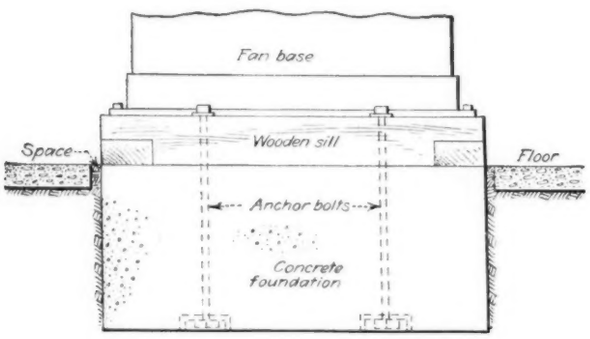

Fig. 1—Concrete base extending below floor level

to absorb vibration. For larger fans and those operated at a higher rate of speed, it is generally best to provide a foundation of concrete from 8 to 12 in. in thickness, extending below the floor to a substantial earth footing, as shown in Fig. 1. This usually comes flush with the floor and a wooden frame is anchor-bolted to it, as previously described. With a good earth bearing it is not necessary to carry a foundation of this kind to any great depth, as the area is large compared with the weight it has to support.

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As an added precaution against vibration the foundation slab may be separated from the floor by a narrow slot, say half-inch or so in width, filled with sand. A break of this kind will prevent any moderate amount of

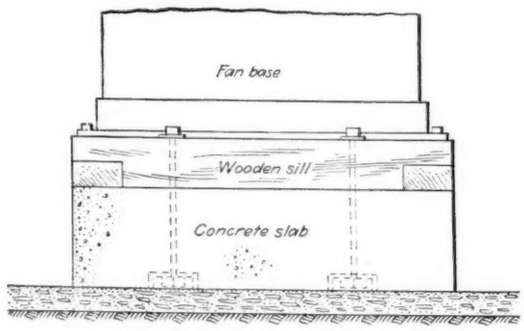

Fig. 2—Concrete slab above floor level

vibration from being transmitted from the fan to the building construction.

When the fan locations are not known at the time the floor is laid and there is ample headroom, the foundation may be placed on top of it, as in Fig. 2, taking care to make it large enough to distribute the weight over a considerable floor area. Such a slab need not usually be more than 8 in. thick for ordinary conditions. There is more danger of vibration being transmitted to the floor with this arrangement, as no separating space is provided in this case.

Usually, the wooden sill will serve to some extent as an absorber of vibration, as previously stated, but this may be increased in effectiveness by placing a strip of cork slab, an inch or so in thickness, between the fan base and sill before drawing down the lagscrews. Such a precaution, in connection with the arrangement shown in Fig. 2, will often overcome the transmission of vibration to the floor.

A method that gives a broader bearing on the cork, and hence makes it more durable, is to build up a sill consisting of two strips of wood with a layer of cork between them, as shown in Fig. 3. In using any kind of material in this way for the absorption of vibration the matter of durability must be taken into consideration as well as immediate effectiveness. While rubber and felt give good results at first, they become hardened after a time and so lose their resiliency. The best and most lasting insulation for this purpose is the natural cork slab, although the pressed slab will last for a considerable length of time.

The best precaution against vibration is a well-constructed and well-balanced fan of such size that it can be operated at a moderate speed. The multiblade type

of fan meets these requirements much better than the older steel-plate type and so is especially desirable where quietness of action is necessary.

If all fans could be located in the basement of a building there would be little trouble in taking care of vibration. As a matter of fact, it is often necessary to place them in the upper parts of buildings, especially those employed for exhaust ventilation, and in some cases the entire fan equipment is placed upon the roof or in an attic space. Under these conditions it is necessary to take great care to support the apparatus so it will not transmit its vibrations to the lighter part of the building construction.

The first location to be looked for in cases of this kind is a heavy wall extending to the foundation. Frequently, fire walls are carried to the attic and stopped at some distance from the roof. For fans of small and medium size a platform can often be constructed upon the top of one of these walls, as shown in Fig. 4. Channel irons, having a length equal to the width of the fan platform or sill, are laid across the top of the wall and fastened in place by means of braces, and the sill bolted to the channels as indicated in the drawing.

For larger installations or where a side wall and overhead girders are available, a platform may be constructed after the general form shown in Fig. 5. If there is much vibration, it can be kept from communicating with the overhead girders by introducing spring hangers in the supporting rods. In other cases the platform may be supported entirely from overhead if a side wall is not available. While a wooden flooring is shown in the drawing, the entire construction may be of metal if desired. When spring hangers are employed, they should always be provided with safety devices for preventing the platform from falling in case the coil springs should break.

When the fan is driven by an electric motor or steam turbine, there is but little added vibration, and the

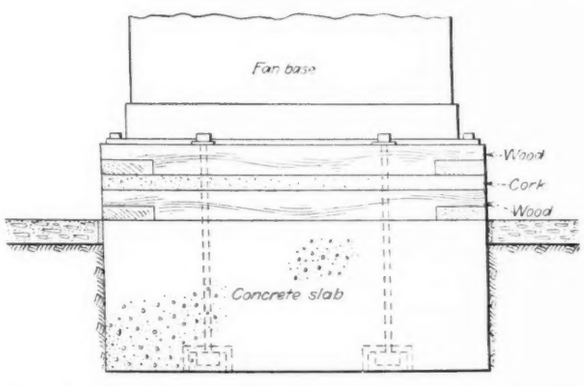

Fig. 3—Double wood sill with cork slab between

foundations for these may be of the same general construction already described. In most cases where direct current is available, the direct-connected unit will be employed, so that the foundation for the driving motor will be simply an extension of that provided for the fan, the two pieces of equipment being mounted on the same bedplate.

When a reciprocating engine is employed, whether direct-connected or belted, more care must be taken with the foundation than for a motor or turbine, which has a purely rotary motion. In general, the support in this case should be carried some distance below the floor and rest on a bed of sand. Unless the earth is fairly hard, an outer wall should be carried around the main foundation and the space filled in with sand.

There should be no direct connection between the engine foundation and the building construction, as any knock in the engine will be magnified and communicated to the floors and walls. The foregoing precautions

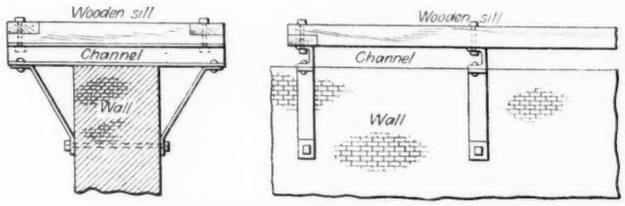

Fig. 4—Fan platform located on top of fire wall

apply especially to cases where extreme quietness of action is required and where fairly high-speed belted engines are employed. Well-constructed and properly adjusted direct-connected units, operating at moderate speeds, may ordinarily be mounted in the same general manner as already described for motors and turbines.

When electric motors are supported upon a separate foundation, it is customary to provide a wooden sill or cap to which the motor may be bolted. This furnishes a convenient means of attaching the machine to the masonry and also serves as an insulator against the leakage of electricity.

Sound insulators of sheet cork or hair felt inclosed between sheets of lead, are often placed between the engine bed and masonry foundation for deadening the sound and eliminating vibration.

Miscellaneous Fan and Motor Noises

In addition to vibrations that may be transmitted through the foundation or support, are other vibrations and noises that must be overcome or reduced in certain locations. One of these is the transmission of vibration from the fan outlet to the galvanized-iron distributing ducts, which immediately magnify and carry it to all parts of the building through the airways. While the vibration itself may not be felt, it produces a humming or roaring noise that is very disagreeable in schools, libraries, theaters and other public buildings. This may be eliminated by introducing a heavy canvas sleeve, a foot or two in length, between the fan outlet and the main duct, as shown in Fig. 6, which illustrates two methods of attaching the canvas to the metal work.

In the arrangement shown at the left, the ends of the sleeve are clamped between the metal flanges and wooden frames, the two being drawn together by means of stove bolts. At the right, flat iron frames and rivets are used. Noises similar to the foregoing may be produced by a vibration of the ducts due to an excessive velocity of the air passing through them. This may be overcome to some extent by stiffening the larger ducts with light angle irons riveted to them and making all joints rigid, so there will be no movement of the ends where the sections are joined.

All dampers and deflectors within the ducts should be held securely in place so as to avoid any rattle or other sounds that might otherwise be produced.

In general, the velocity in the large rectangular iron ducts employed in schools and other public buildings,

should not exceed 1,000 to 1,200 ft. per min. in the main trunk lines, nor 800 to 900 in the branches. If it is necessary to employ higher velocities on account of limited space, the ducts should be made of heavier iron, well stiffened with V-strips or angle iron, or they may be constructed of cement on wire lathing, properly smoothed inside.

In case of factory work, where round ducts are used, velocities of 1,500 to 2,000 ft. per min. are allowable, as a circular duct is more rigid than a rectangular one of the same weight of metal, and a certain amount of noise is not objectionable in most industrial plants. However, high velocities not only produce noise and vibration, but greatly increase the power for driving the fan, so a balance must be made among the various governing factors in order to strike the most desirable average when all points are considered.

When direct-current low- or medium-speed motors are employed, there will be practically no difficulty from noise or vibration, but if high-speed alternating-current machines are used, there is liable to be a humming sound which may prove objectionable in certain types of buildings. The only way to eliminate or reduce this is to cover the motor with a wooden box or housing lined with asbestos. This should be provided with openings at top and bottom so as to produce sufficient air circulation around the motor to prevent overheating.

Fan Drives

Ventilating and blast fans are driven by steam engines, steam turbines, electric motors, and from line-shafting. While gas or gasoline engines may be employed, so far as power is concerned, steam or electricity is usually available in buildings where fans are used, and motors driven by these are preferable to those employing gas or gasoline, as engines of the latter type

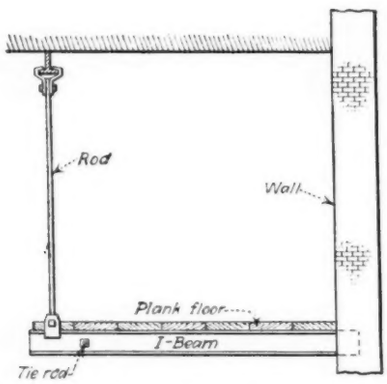

Fig. 5—Fan platform supported from girder and side wall

are comparatively noisy and the odor of gas is likely to find its way into the fan suction and be carried to the rooms above.

Steam Engines

The advantages of the steam engine as a means of driving ventilating and blast fans include the ease with which the speed may be regulated, and the economy of operation when the exhaust can be utilized in the main heater. The importance of speed regulation will depend to a large extent upon the type of building and special service required of the fan. In some cases the full amount of air is required at all times, and the quantity of heat supplied is varied by changing the temperature of the air, while in others it is desirable to maintain a fairly constant air temperature and vary the volume delivered. In certain buildings the volume of air required varies at different parts of the day, so that speed regulation is an important factor. In case of mechanical draft ease of automatic speed regulation is of much importance, and the steam engine lends itself to this condition in a satisfactory manner. Whether

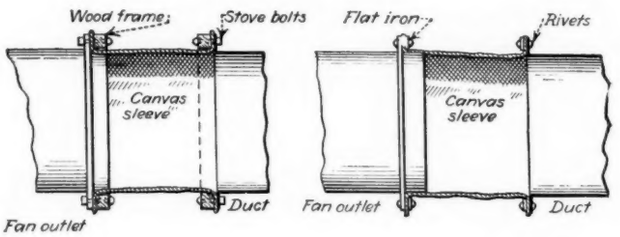

Fig. 6—Canvas sleeve between fan and distributing ducts for eliminating vibration

or not the exhaust can be utilized in the heating coils has an important bearing on the matter of economy, as the size and type of engine used for the driving of fans is usually wasteful in the use of steam.

In a general way, engine drives for ventilating fans are more likely to be found in industrial plants or in office buildings, where quietness of operation is not so essential. When directly connected to the fan shaft, any slight knocking of the brasses is likely to be communicated to the airways in a magnified form, and if this is avoided by using a belted outfit, there is likely to be more or less noise from the belt, which is equally objectionable. Again, an engine requires more attention than a motor and must be kept absolutely free from the odor of oil if located in a room through which the fresh air passes. If, for any reason, it is desirable to use an engine where quietness and cleanliness are necessary, types of machines may easily be found that will meet these requirements if proper care is taken in their installation and adjustment, and many outfits of this kind are giving satisfaction in public buildings of all kinds.

Turbine Drive Sometimes Used

Engines especially designed for fan work are furnished by the leading fan manufacturers. These are both inclosed and partly inclosed, vertical and horizontal, and arranged for either direct connection or belt drive. In general, they operate on pressures from 15 lb. up, and are constructed with cylinders of comparatively large diameter and short stroke, to reduce vibration as much as possible at high speeds. When for any reason it is desirable to use a belt connection, it should be light, pliable and of good width, rather than narrow and of heavy material. The joints should be lapped and glued rather than laced.

Steam turbines have practically the same advantages as the engine so far as speed regulation and utilization of the exhaust are concerned, but are more generally used in connection with pressure blowers requiring a high speed and coupled directly with the fan shaft. While they produce much less vibration than reciprocating engines running at the same speed and may be set on lighter foundations, there is considerable noise, which is common to all high-speed drives, thus confining

them largely to industrial work. Special low-speed turbines have been designed which adapt them to a wider range of conditions in this particular field, and direct drive at still lower speeds is made possible by the geared machine which makes use of herringbone gears.

For public buildings, such as schools, churches, libraries, theaters and municipal buildings, the electric drive offers advantages that make it popular. In many cases electricity for power and lighting is purchased from a central station, so in buildings of this kind it is only necessary to install low-pressure boilers for heating and operate the fans by motors. Again, in plants generating their own electricity the fans are often operated through the summer months with the heaters shut off, and electric drive makes it possible to shut off steam in the boiler room instead of keeping it on all lines leading to scattered fan engines. In large buildings a number of fans are often required, and motors are more easily looked after than engines. This last point is of so much importance that many of the latest office buildings and industrial plants, where high-pressure steam is available, make use of electric drive for the fan motors on the score of convenience.

Motors Must be Reliable, Efficient and Quiet

One of the first requirements of a satisfactory fan motor is reliability, as the unit is frequently placed where frequent supervision is impossible, hence the motor must be able to operate constantly with but little care and attention. It should, in general, be dust and moisture proof, with dependable lubrication and non-leaking bearings. High efficiency is also an important factor, because the fan in many cases is operated continuously throughout the working hours of a plant, and a difference of 2 or 3 per cent in the energy consumed will amount to a considerable item in the yearly operating expense. Quietness of action is also important in many types of buildings, as previously noted in connection with engines and turbines, which means a motor of comparatively slow speed.

Mechanically, the motor should be light and compact, and when it is to drive an overhung fan it must have ample strength of shaft and bearings to support the fan. While either the direct-current or alternating-current motor may be used for driving fans, the former is preferable because it can be obtained in all sizes for slow speeds, and furthermore, speed regulation is much more satisfactory. A slow-speed motor may be directly connected with the fan shaft, thus making a compact and quiet-running unit, which is desirable in most installations.

Alternating-current motors of small size are not unusually made in slow speeds and must generally be belted to the fans they are to drive.

Direct-current motors employed for fan work are of the shunt type, designed either for constant speed or for speed control in three different ways. The normal speed of a direct-current motor is the speed at which it is designed to run under full load without resistance either in the armature or the field circuit. When the fan is to operate continuously at constant speed, a motor of the proper normal speed is selected, and the control equipment consists of a starter. In general, it is desirable to have a certain amount of speed control, as the quantity of air required may vary at different periods of the day or season of the year; furthermore, it is difficult to estimate beforehand just what the resistance will be, so that it is necessary to vary the rated speed of the fan somewhat after the installation to obtain exactly the quantity of air desired.

The speed of a shunt motor may be increased by introducing resistance in the field, and reduced by increasing the armature resistance, which is the most desirable method because the loss in motor efficiency is negligible. With armature resistance there is a loss of approximately 20 per cent in reducing the speed one-half. When using field control only, the normal speed of the motor is made to correspond with the lowest speed desired, higher speeds being obtained by use of the controller. In case of armature control, conditions are reversed and the normal speed is made the maximum. Field and armature control are often combined in the same machine, speeds above normal being obtained by means of field control and those below normal, by armature control. The best arrangement for speed regulation in any given case will depend on the range in speed desired and the proportion of time the motor is to be operated at its normal speed.

Push-Button Control

Ordinarily, the starter is of the hand-operated type, but automatic starters, operated by push buttons from one or more conveniently located stations, are coming into general use, as a matter of both convenience and safety. Automatic control usually consists of start-and-stop push buttons, with a manually operated speed-changing rheostat on the main control panel, but it is also possible to control the speed by means of push buttons.

There are two types of alternating-current motors in general use for operating fans, the squirrel-cage and the wound-rotor. The former is the simpler and is always used when possible if the fan is to be operated at only one speed.

The wound-rotor machine is similar to the squirrel-cage, except that the construction is such that resistance can be introduced into the rotor, which makes it possible to secure a certain amount of speed control. The results in this case are practically the same as with a direct-current motor under armature control; that is, 50 per cent speed reduction with an efficiency loss of about 20 per cent.

Multi-speed squirrel-cage motors and polyphase brush-shifting motors have also been successfully used for driving fans.

It should be stated in connection with alternating-current motors that they may be adapted to fan work with satisfactory results, under ordinary conditions, when direct current is not available.

The smaller sizes of direct-connected motors are usually attached to the fan casing by an annular side plate, while those of larger size require a base-plate supported by an extension of the fan foundation.

In most cases it is best to drive a fan by its own motor, or engine, so as to make it independent of the rest of the plant, as it is often desirable to start up the heating or ventilating system before the lineshafting is in operation. There may be cases where it is more convenient and economical to drive from the lineshaft, as where the building is heated by direct radiation, and it is only necessary to run the fan for ventilating purposes during working hours, and even then only a portion of the time. When it is to run continuously, it may be belted to a convenient lineshaft, but if it is desired to shut it off at any time, use should be made of a friction clutch or tight and loose pulleys.

Oil Engines Practical Even if Process Steam Be Needed

Dallas Oil & Refining Co. Uses Diesel for Power and Boilers for Process Steam—Results Show Attractive Saving in Power Costs

BY J. S. LE CLERCQ*

OWNERS of factories requiring steam for process work often feel compelled to continue to operate steam engines for power under the impression that the necessity of keeping boilers in service prevents the use of a more efficient prime mover. That this does not hold true at all times is evidenced by the successful operation of a Diesel engine in the Dallas Oil & Refining Co.'s oil mill at Dallas, Tex.

In the recovery of oil from cotton seed two processes are available. One of these is basically the crushing of the seed and the recovery of the oil by passing the meats through expeller presses. Since the meats are not cooked before the oil is extracted, this process is known as the *cold press* system. This method, since no steam heating is needed, permits the use of any available source of power to operate the machinery. The cost of crushing, etc., is low, but the system has the disadvantage that the oil recovery per ton of seed is low, more than offsetting the lower power costs.

The second and more generally used system is the *hydraulic press*. In such plants the meats are cooked by steaming, before the oil is extracted, through the agency of hydraulic presses. The recovery per ton is far more than enough to compensate for the steam used in the process. Since power is an expensive item in such mills, engineers have always been desirous of introducing ways and means of reducing it. Diesel engines have been recognized as producing power at a low cost, but the fact that process steam was necessary has largely prevented their use by cottonseed-oil mills.

That an arrangement where a Diesel engine supplies the power and steam boilers furnish the process steam is not only feasible but economical, is proved by the satisfactory operation of the Dallas plant. The power plant consists of a 750-hp., four-cylinder, two-stroke-cycle Diesel, shown in Fig. 1. A 312-kva. three-phase 60-cycle 480-volt generator is direct-connected to the engine and supplies power to outlying motors in and around the plant as well as current for lights, etc. A rope drive handles the main mill machinery, the driving pulley being carried on a short shaft connected to the engine's extension shaft through a friction cutoff coupling.

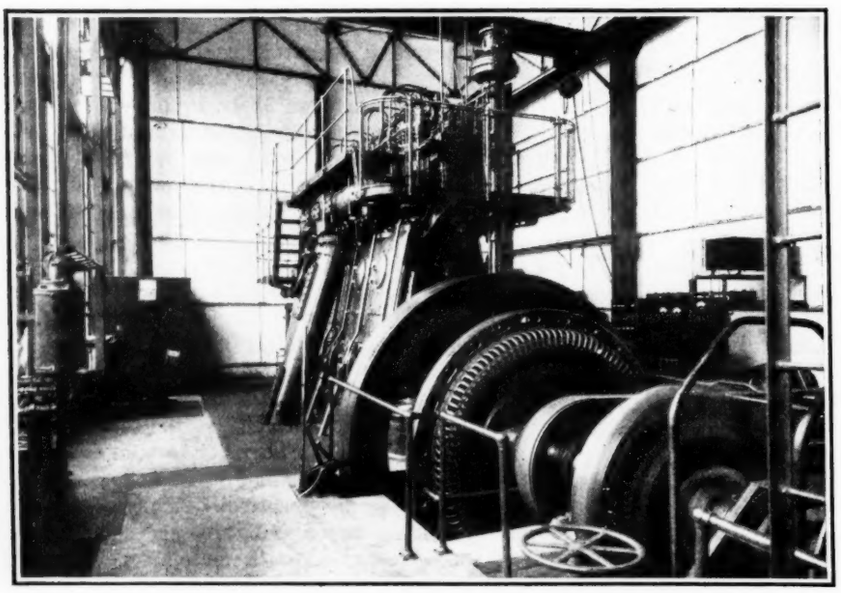

Fig. 1—View of power house interior

The plant contains several accessories not usually found in plants of this capacity. Air for the engine is taken from above the building roof and enters through a sheet-steel pipe. Before going to the scavenging pump, the air passes through an air filter consisting of a set of trays filled with disks coated with a sticky substance. Dirt particles in the air are caught by this filtering medium, eliminating all danger of grit entering the engine. The location of the filter is shown in Figs. 1 and 2, being placed in one corner of the room.

The fuel oil is stored outside the building and is lifted to the overhead service tank by an electrically operated rotary pump; duplex oil filters remove any dirt or sediment.

The lubricating oil, after passing through the several bearings under pressure, flows through a cooler and filter. At stated occasions the oil is put through a centrifugal filter to remove any emulsion, carbon or dirt. This procedure has proved to be most satisfactory, the oil recovering its original color and lubricating qualities.

The engineers who were in charge of the boilers and steam engines formerly in the plant, operate the Diesel. They had no difficulty in acquiring an understanding of the engine and are able to keep it in service from Sunday midnight to Saturday midnight. In oil-mill work it is necessary to have 144 hours' continuous operation each week during the ten months of the crushing season, and the oil engine has been able to do this without undue labor on the part of the engineer.

The load varies during the day's run, averaging 600-hp. The fuel consumption is approximately 0.4 lb. per horsepower-hour, while between 4 and 4½ gal. of lubricating oil is used each 24 hours. Power from the oil engine is costing not over one-fourth the cost with

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the steam engine that was formerly used, and the management is confident that the entire power-plant investment will be returned by the savings in five seasons.

The steadiness of the speed is indicated by the clearness of the flywheel outlined in Fig. 1. So well balanced and closely governed is the engine that the motor load may be thrown on and off without affecting the voltage to any extent.

The engine-room layout was designed with the idea of making the operating procedure as simple and labor-saving as possible. All accessories are on the floor level and so grouped about the building walls as to be accessible at all times. A traveling trolley crane serves the engine so that if it ever becomes necessary, any part of the engine can be removed and shifted to the working floor. The locations of the accessories are shown in Fig. 2.

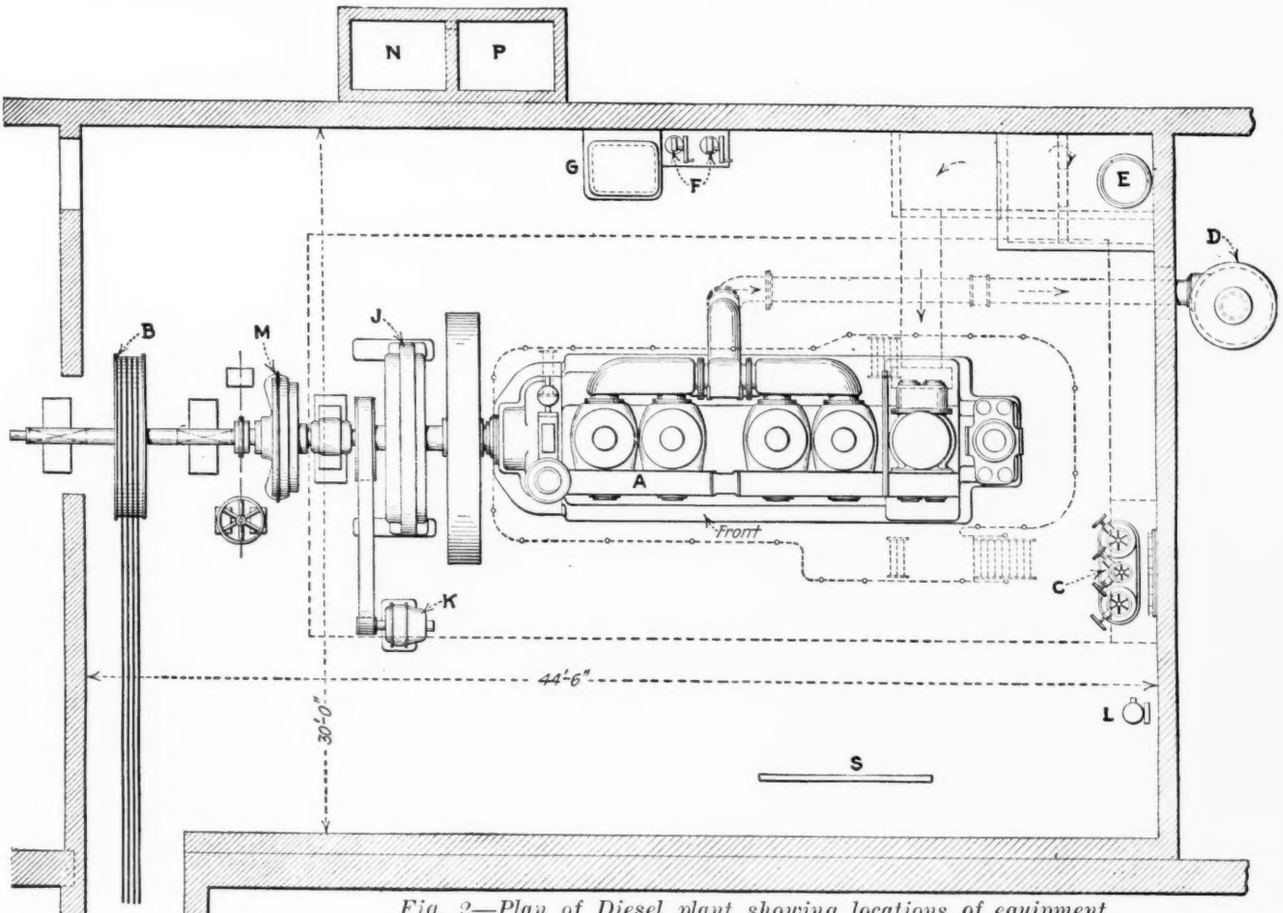

Fig. 2—Plan of Diesel plant showing locations of equipment

LIST OF EQUIPMENT

A—750-b.hp. Busch-Sulzer Diesel engine.
B—Hill, 80-in., 12-groove, 1¼-in. rope driving pulley.
C—Air starting tanks.
D—Exhaust muffler.
E—Mid-West scavenging-air filtering system.
F—Hand-service fuel-oil pumps.
G—Fuel-oil service tank located on side wall above engine fuel pump.
J—312-kva. 480-volt 3-phase 60-cycle G.E. generator.
K—17½-kw. G.E. 110-volt belted exciter.
L—De Laval centrifugal lubricating oil separator.
M—Hill friction clutch cutoff coupling.
N—Suction well for cooling water to engine.
P—Hotwell for cooling water discharged from engine.
S—Switchboard.

Why the Combined Plant Is Economical

When the plan of installing an oil engine was first broached, there was some question raised as to the economy of using a Diesel while still keeping the boilers to meet the process-steam demand. Without investigation it might appear most illogical to use the combined plant. However, the process-steam demand and the power demand do not coincide, and even though a steam engine be operated at a high back pressure to supply the process steam, much live steam would be needed. The success of this system indicates that there are possibilities of reducing manufacturing costs in the majority of cotton-oil mills. The reduction in the labor element is of vital importance for, as with most Southern industries, high-grade labor is scarce. While the new plant has not been operated long enough to allow one to determine the maintenance to be expected over a long period, the absence of repair charges at the present time indicates that this cost item will be comparatively small.

The Bulletin of the American Society for Testing Materials quotes the Subcommittee on Standardization of Anthracite Sizes as reporting progress on the standardization of names and sizes of anthracite coal as used in the trade. These are:

	Round Hole Sieves	
	Pass Through	Retained On
Broken (Furnace)	4½ in.	3½ in.
Egg	3½ in.	2⅝ in.
Stove	2⅝ in.	1⅞ in.
Chestnut (Nut)	1¼ in.	¾ in.
Pea	¾ in.	½ in.
Buckwheat No. 1	½ in.	¼ in.
Buckwheat No. 2 (Rice)	¼ in.	9/64 in.
Buckwheat No. 3 (Barley)	9/64 in.	5/32, 1/16 in.
Buckwheat No. 4 (Culm)	5/32, 1/16 in.	

Checking the Performance of the Turbine Room

By Theodore Maynz*

In a previous article (*Power*, Feb. 5) the method followed in continuous testing of the boiler plant was outlined. While the boiler room's daily performance is of interest and the daily check of value, the over-all plant efficiency is largely dependent upon the conditions in the turbine room, including the operation of the auxiliaries.

The treatment of the turbine room is usually simpler than that of the boiler room. As a rule there are no steam meters to individual turbines, but their performance is nevertheless interesting, especially if they are of different types or sizes. Even if the steam is metered, inaccuracies can be checked by means of performance curves. Such a curve giving the test performmance of a turbine at various loads, plotted so that the water rate at various vacua and superheats can be obtained easily, is shown in Fig. 1. Pressure variations are neglected, as the water rate of a turbine is changed about 1 per cent for every 20 pounds, and as the usual pressure regulation is less than one-half of this value, the pressure fluctuations can be neglected. The operating temperatures and conditions can be obtained from the turbine-room logs, which should show half-hourly readings of vacuum, condenser temperatures, temperatures of the exhaust steam used in the auxiliaries and readings at least every eight hours of the barometer and of inlet-water temperature. These readings should be obtained and should be logged even if recording instruments are used.

The average water rate obtained from a chart of this type times kilowatt-hour output will give accurate data on the total steam used by the turbines. To this must be added the steam used in starting, which can be obtained by simple tests.

If the makeup and the plant water rates are accurately measured, or if the turbine water rate and the plant water rate are known, the other two factors are easily determined by a heat balance on the heaters. Using the following nomenclature:

W_F = Plant water rate, or total plant steam;
W_T = Turbine water rate, or total steam;
W_A = Auxiliaries water rate, or total steam;
W_M = Makeup water rate, or total makeup;
H_S = Total heat in high-pressure steam;
H_e = Total heat in exhaust steam from auxiliaries;
T_F = Feed-water temperature;
T_C = Condensate temperature;
T_M = Makeup temperature.

The two equations are:

$$W_F = W_T + W_A + W_M \qquad (1)$$

of which two factors are accurately known, and

$$W_F \times (T_F - 32) = W_T(T_C - 32) + W_A \times H_e + W_M(T_M - 32) \qquad (2)$$

Assuming that W_F and W_T are known, and substituting $W_M = W_F - W_T - W_A$ for W_M in equation (2), we get $W_F(T_F - 32) = W_T(T_C - 32) + W_A \times H_e + (W_F - W_T - W_A)(T_M - 32)$, where W_F and W_T are known. We can now solve for W_A, and with this value find W_M, thus determining all the factors in the plant water rates.

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All the temperatures are easily measured, and the total heat in the exhaust steam from the auxiliaries can be measured by means of a thermometer and a pressure gage if the exhaust is superheated, as is the usual case with turbine-driven auxiliaries, or with a pressure gage and calorimeter if the exhaust is wet. These temperature measurements should be taken as close to the heater as possible.

With these measurements a simple heat balance can be made, which represents the quantitative heat values used and lost by the turbine-room apparatus. This balance is based on the kilowatt-hour which is equivalent to 3,415 B.t.u.; thus the input and all the various losses occurring in the turbine room are calculated in

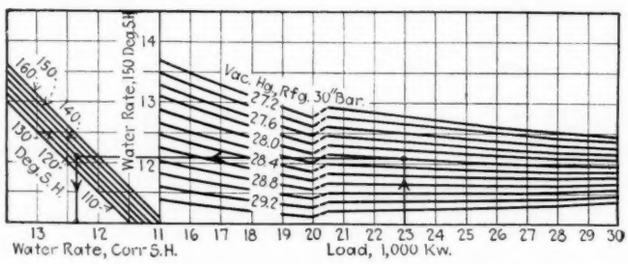


Fig. 1—Steam consumption of turbine with variation in load and pressure conditions

B.t.u. per kilowatt-hour. Such a heat balance is shown at the bottom of the Turbine House report, items 1–9 inclusive, Fig. 2.

Item 1, The Gross Input, equals the plant water rate per kilowatt-hour times the total heat in the high-pressure steam at the turbines, or $W_F H_S$.

Item 2, Returned by Heaters, is the plant water rate times the heat in the feed water (above 32 deg. F.), or $W_F(T_F - 32)$.

Item 3, Net Used, is the difference between the two foregoing items and must equal the total generation and losses, item 9, which is the sum of items 4, 5, 6, 7 and 8.

Item 4, Energy Generated, is one kilowatt = 3,415 B.t.u.

Item 5, Energy Lost in Turbines, is the mechanical and electrical efficiency of the unit and includes bearing losses, generator losses and, if the exciter is attached to the generator, the exciter losses. This efficiency value K will vary for the type and size of machine, but will be a constant after its value has been determined.

The energy lost in the turbines is found as follows: Energy output = input × mechanical efficiency; Input = output ÷ mechanical efficiency = $\frac{3,415}{K}$; Energy lost in turbine = input — output = $\frac{3,415}{K} - 3,415$.

Item 6, Energy Lost in Condensers, equals the difference between the energy feed to the turbines ($W_T H_S$) and the energy converted by the turbines $\left(\frac{3,415}{K}\right)$ minus the energy returned from the condensers by the condensate $[W_T(T_C - 32)]$, T_C being the condensate temperature. Energy lost in Condensers $= W_T(H_S - T_C + 32) - \frac{3,415}{K}$.

Items 5 and 6 can be combined to simplify the calculations, so that the Energy lost in Condensers and Turbines $= W_T(H_S - T_C + 32) - 3,415$, eliminating the question of the turbine and generator efficiency K.

Item 7, Energy lost in heaters and auxiliaries, $= W_A H_S + W_T(T_C - 32) + W_M(T_M - 32) - W_F(T_F - 32)$, and

Item 8, Energy Lost in miscellaneous, $= W_M(H_S - T_M + 32)$.

This last method of analyzing the performance of a turbine plant is applicable primarily to larger plants, but is so simple to calculate and gives such valuable data that a detailed example will be worked out.

Plant water rate = 14.40 lb. per kw.-hr.....W_F
Makeup water = unknown.....W_M
Feed temperature = 180 deg. F.....T_F
Auxiliary exhaust total heat = 1,174 B.t.u...H_E
Makeup water temp. = 100 deg. F.....T_M
Condensate temp. = 90 deg. F.....T_C
Vacuum, referred to 30-in. bar.....28.2 in.
Steam pressures, lb. gage 225
Superheat, deg.....130 deg.
Total Heat in 1 lb. steam, B.t.u.....1,277.5 = H_S

Using the curve in Fig. 1, we find that for the average turbine load of 23,000 kw., with 28.2 in. vacuum and 130 deg. superheat, the water rate is 12.35 lb. per

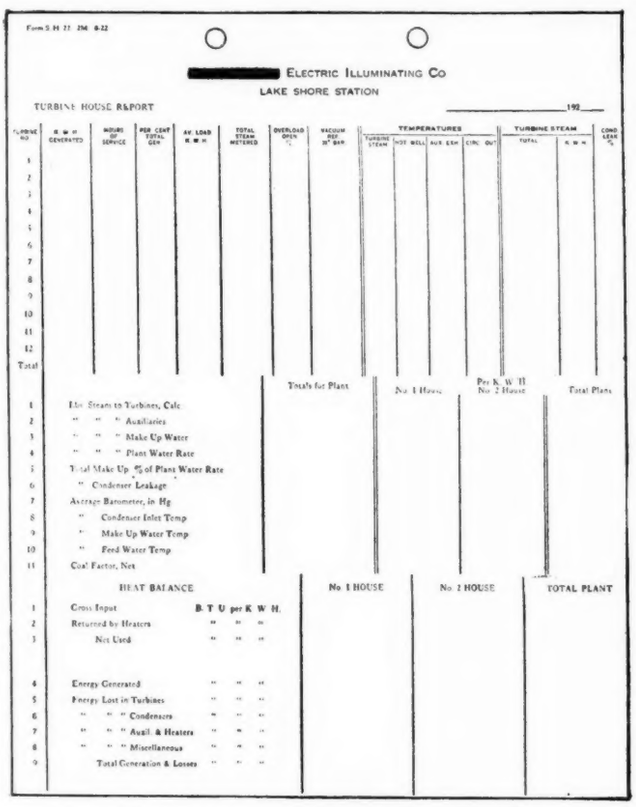


Fig. 2—Log and heat balance sheet

kw.-hr. Substituting the foregoing figures in the equations referred to previously, we get (equation 2):

$$W_F(T_F - 32) = W_T(T_C - 32) + W_A H_E + W_M(T_M - 32), \text{ or}$$
$$14.40(180 - 32) = 12.35(90 - 32) + W_A \times 1{,}174 + W_M(100 - 32).$$

Substituting the proper values in the equation (1) $W_F = W_T + W_A + W_M$, we have $14.40 = 12.35 + W_A + W_M$, and $W_M = 2.05 - W_A$.

Substituting $W_M = 2.05 - W_A$ in equation (2), we get $2{,}131.2 = 716.3 + 1{,}174\,W_A + (2.05 - W_A)68$. Transposing, the equation becomes

$1{,}174\,W_A - 68\,W_A = 2{,}131.2 - 716.3 - 139.4$, or $1{,}106\,W_A = 1{,}275.5$.

The auxiliary steam, W_A, is then 1.15 lb. and the makeup, W_M, is 0.90 lb.

The heat balance of the heat required to deliver 1 kw.-hr. is as follows:

Gross input (item 1) = 14.40 × 1,277.5	18,396.0 B.t.u.
Returned by heaters (item 2) = 14.40 × (180 — 32)	2,131.2
Net used by turbine room	16,264.8 B.t.u.
Energy generated (item 4) = 1 kw.-hr.	3,415.0 B.t.u.
Energy lost in turbines and condensers (item 5) = 12.35 × (1,277.5 — 90 + 32) — 3,415	11,645.8
Energy lost in auxiliaries and heaters (item 7) = 1.15 × (1,277.5) + 12.35 × (90 — 32) + 0.90 × (100 — 32) — 14.40 × (180 — 32)	115.4
Energy lost in miscellaneous (item 8) = 0.90 × (1,277.5 — 100 + 32)	1,088.6
Total generation and losses	16,264.8 B.t.u.

It will be noted that all boiler-room miscellaneous loss such as soot-blower steam, blowdown, high-pressure drips, safety blows, etc., are charged to "turbine miscellaneous losses" rather than segregating them and deducting them. This simplifies the problem and does not detract from the value of the information obtained.

[This article completes the information for boiler and turbine operation. The third will show the necessary curves and calculations for detailed test data on boiler performance and general plant heat balance.—Editor.]

Gas-Engine Connecting Rods

BY H. T. MELLING

In a plant containing several large double-acting gas engines the connecting-rod bearings at the crank ends had been causing considerable trouble, such as breaking the wedge bolts and fracturing the bearing metal, which brought about the usual hot bearings when operating under these conditions.

On the engines being first erected wood liners were used as packing pieces between the bearings at the crankpin end of the connecting rod. The usual practice for adjustment was to pull the wedge up until the bearings gripped the pin; the top wedge bolt was then slacked back 2¼ flats of the hexagon head and the bottom bolt tightened down, which gave the desired clearance for the 8-in. diameter crankpins. These wood liners soon became loose, allowing the bearing shells to move to and from the crankpin at each stroke. This vibration caused the wedge bolts to crystallize and also assisted in fracturing the babbitt metal in the bearings.

It was decided to do away with wood packing pieces and make the two halves of the bearing solid to each other by introducing metal shims, the thickness of which controlled the clearance.

Two sets of liners had to be made for each connecting rod, which consisted of two pieces of ⅜-in. thick brass held together by dowel pins.

The crankpin end plate was cut away to allow the liners to be drawn without dismantling the plate and the lubricating connections to the crank. A piece of steel was filled into this slot, which was secured to the plate by a cap screw. This prevented the lubricating oil from being thrown out.

The adjustment of the bearing was obtained by tightening the bearings on the crankpin, then measuring the spaces between the bearing shells top and bottom, the shims being made equal to these measurements plus twelve one-thousandths of an inch.

Burning Small Sizes of Anthracite*

By ALBERT A. CARY
Consulting Engineer, New York City

IT IS difficult to conceive why Mr. Coxe, who built the first chain-grate stoker with windboxes in 1892, should have selected this type to burn small-sized anthracite.

With a number of minor modifications the chain-grate stoker has been used for burning bituminous coal since 1838, for which service it is admirably adapted, provided the coal is not of the caking variety. With such coal this type of stoker operation follows the coking method of firing.

This method is clearly illustrated in Fig. 1, where, with a hand-fired furnace and starting with a bright burning bed of coal upon its grates, a fresh charge of "green" coal is piled across the entire width of the furnace at its front end. The heat from the incandescent fire bed behind this transverse heap of coal rapidly distills off the gaseous matter, which quickly fires and burns as it passes over the hot bed of glowing coal in the rear. When the gas has been driven out of the coal, the fireman shoves back the front pile. This coke-like fuel rapidly ignites as it is spread over the hot fuel bed in the rear, forming a renewed bed of glowing coke and igniting the gas as it issues from the next charge of green coal.

As the coke in the rear burns away, such remaining ash and clinker as does not pass through the grate-bar openings has to be removed so as not to interrupt the free flow of air through the fire bed. With the design shown in Fig. 1, invented by Chanter in 1843, the fireman shoves the remaining refuse back onto the rear dumping grate and dumps it into the ashpit.

It is easy to follow the successive steps occurring on the top surface of the chain grates, where the fresh bituminous coal is conveyed by the chain to the front end of the fire bars, and as the gases are driven out the resulting coke passes back on the moving grate surface. The grate is supposed to have its speed regulated so as to give ample time for the combustible to burn out of the coke and thus reject nothing but ash and clinker over the rear end.

This is a most rational combustion process with bituminous coal, but such is not the case when one attempts to use anthracite. This fuel carries a very low percentage of volatile matter, and therefore there is no light porous coke formed as this coal is moved back into the heat zone of the furnace. Instead of requiring a rise in temperature to approximately 670 deg. F., the temperature at which bituminous coal takes fire and burns, anthracite must have its temperature raised to more than 925 deg. before igniting. These are the reasons why expensive reverberatory arches must be included in such stoker furnaces when using anthracite.

When the source of heat needed for combustion is applied to the underside of an overfed fuel bed, with a sufficient supply of air present, we find that the most rapid and complete burning of the combustible gases occurs if they are ignited the instant they leave the coal. At this point the pound of gas, so compactly stored in the solid fuel, expands into a great many cubic feet of space in the combustion chamber, where the concentration of heat is much less and the difficulty in uniting the combustible gas with the oxygen of the air is greatly increased.

The first action taking place in this type stoker as the anthracite enters the interior of the furnace on the moving grate, is the evaporation of the moisture, the total moisture in small-sized anthracite often running as high as 14 per cent, and a moisture content of from 4 to 5 per cent is quite common. The evaporation and superheating of such an appreciable amount of water in an inclosed furnace is a very appreciable endothermic (heat-absorbing) process, which lowers the furnace temperature, thus reducing the rate of burning the carbon monoxide gas.

The introduction of air into the furnace chamber by use of a steam jet delays combustion due to the presence of steam. It must further be recalled that the air itself must be raised to a temperature of over 1,200 deg. before combustion can take place, as that is the ignition temperature of the carbon monoxide. Cold air and hot gases never mix in combustion processes. After the coal loses its moisture, the heating must continue until the coal reaches its critical temperature of ignition, and not until then does it take fire and burn. By this time the unburned coal has traveled with the moving chain grate from one-quarter to one-third of the length of the grate, absorbing heat all this time and contributing nothing to the operating of the furnace.

Then, as this coal starts to burn, comes the violent rush to complete this combustion in the shortest possible time. All the highly heated radiating surface that can be massed up against it in the overhead arches and surrounding refractory walls is forced to contribute its utmost radiant heat energy to the coal. The air supply at this central third of the grate is forced up through the fuel bed to meet the demand for combustion and carries a dust cloud of fine ashes with it through the boiler setting. Even then, with all of this elaborate setting it is found that a considerable amount of unburned gases is leaving the furnace or combustion chamber unconsumed, notwithstanding an introduction of secondary air above the fire bed, and as a result, secondary combustion is taking place over the first pass of the boiler tubes and possibly beyond there.

It is really too much to expect the complete combustion of such a large amount of coal to take place on merely the central third of the length of the furnace or on even one-half of the length of the grate travel. By spreading the combustion evenly over the entire furnace

THIS is a discussion of the firing methods in plants using the small sizes of anthracite. Mr. Cary was prompted to outline his views by reason of a paper by A. R. Mumford read before the Metropolitan Section of the American Society of Mechanical Engineers, Jan. 15, 1924, and published in "Power," Feb. 19.

*Extract of discussion before the Metropolitan Section American Society of Mechanical Engineers, Jan. 15, 1924, at New York City.

area, as might be possible with other means of mechanical firing, a much better result and a simpler construction of furnace and process of combustion could be looked for.

The rear third of the grate travel is merely used to burn out the combustible matter accompanying the ash and refuse which remain after passing the control zone so that as little as possible of combustible matter will be

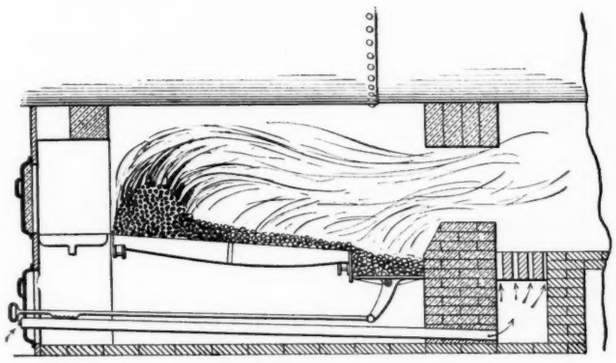


Fig. 1—Coking method of firing

wasted over dumping end of the grate, and for this purpose other rear ignition arches are often constructed.

Having found that the coking method of firing or its automatic fuel-handling developments do not furnish the best means for handling anthracite in a furnace, we naturally ask, How then are we to burn this fuel by machine methods?

When attempting to solve such problems, I never forget a helpful suggestion received during my student days when I was endeavoring to master the intricacies of machine design; namely, that when endeavoring to work out a new mechanical design, always stop and think first how you would accomplish the desired result by hand or other muscular means, and then improve upon such processes or manipulations by a combination of fixed and movable machine elements arranged so that the natural energies at our disposal may be transformed into the required work.

Hand Firing of Anthracite

Following this rational process, it will be readily agreed that one would never think of hand firing an anthracite furnace by using the coking method of stoking. All firemen follow the sprinkling method for charging this kind of coal upon the fire body, covering the entire surface of the burning fuel with a thin layer of green coal. Under these conditions all the fresh fuel is quickly raised to its ignition temperature and burned, thus making 100 per cent of the furnace area efficient fuel-burning surface.

When burning the smaller sizes of anthracite, a forced blast system delivering air under pressure beneath the grates is essential, and a change in the pressure of delivered air adapts the furnace to variable loads.

If we wish to change from the hand-fired to the machine-fired method of stoking, we have merely to glance over the various stoker designs in use, especially in the English and European fields. A variety of sprinkling stokers will be found which have stood the test of service, and it requires only the use of a little ingenuity to adapt this style of stoker to our purpose.

Fig. 2 shows a sectional view of the Proctor stoker applied to an internally fired boiler, having an overhead hopper, discharging its contained coal by gravity into the outer end of the ram box *B*, which communicates through a bottom opening at its inner end with the shovel box *C*. The ram *I* pushes back to the opening a definite amount of coal at each stroke, which drops down in front of the shovel *W*. The shovel flap has its lower tip end moved back in the shovel box *C* by a partial revolution of its shaft. This motion of drawing back the shovel tip is strongly opposed by an attached extension spring, not shown, so the moment the revolving disk pin on the shaft turns to a position below the lower level of the tappet arm, the shovel blade is then released, and as the attached extension spring has been well extended, its stored power is instantly released, thus throwing back the lower tip of the shovel, which catches the fixed charge of coal which has been delivered to the shovel chamber *C* and flips it suddenly into the furnace. The act is done with all the energy of a shovel in the hands of a well-trained fireman, and the required amount of coal is landed precisely on the rear portion of the fire bed *Q*.

Results with Sprinkling Stokers

The details of how the motion of the shovel is regulated to throw the coal to the front as well as to the rear will not be described.

Fig. 3 is another device, originally designed by Schwartzkopff for feeding pulverized coal to a furnace. I had an opportunity to experiment with a modification of this device, after finishing some trials with pulverized coal for which it was designed. Finding some small-

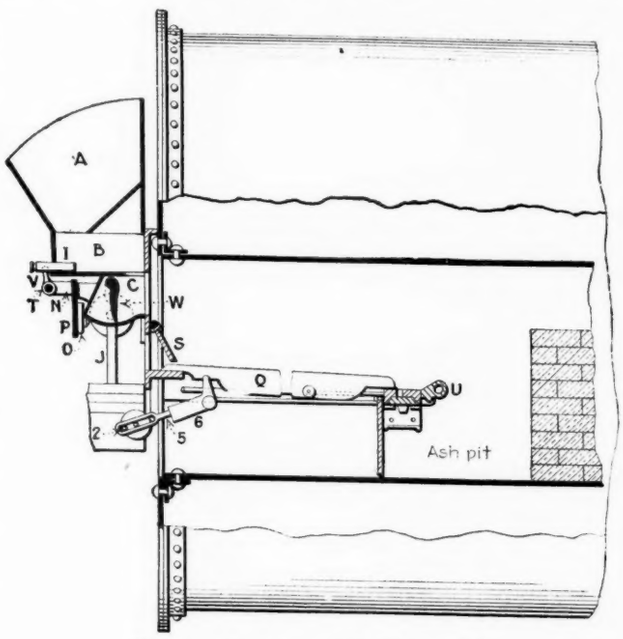


Fig. 2—Proctor sprinkling stoker

sized anthracite used under an adjoining boiler, I experimented with the adaptability of such a revolving brush, with wire bristles, for feeding buckwheat coal to the furnace, and the results were most encouraging.

By varying the speed of revolution of the circular brush *B* it was easy to distribute the coal evenly over the fire bed, and a considerable length of surface would be taken care of. The amount of coal fed is regulated by *A* and *D*.

Theoretically, with an even-top sprinkler system of charging coal upon the fire bed there should be a corresponding even-bottom cleaning method, with means for breaking up the fire bed when and where needed. Such a system of operation would give the ideal equipment and make every square foot of the fire-bed surface equally efficient and effective.

If shaking grates were operated along with one of the above-described automatic sprinkling methods of feeding small-sized anthracite, I believe that the efficiency in the furnace would be equal to that with machine grates.

With well-designed shaking and dumping grates under boilers, properly set and with proper draft provided, I have upon more than one occasion given neighboring stokers, in competitive tests, some pretty close calls in their endeavors to show better efficiency.

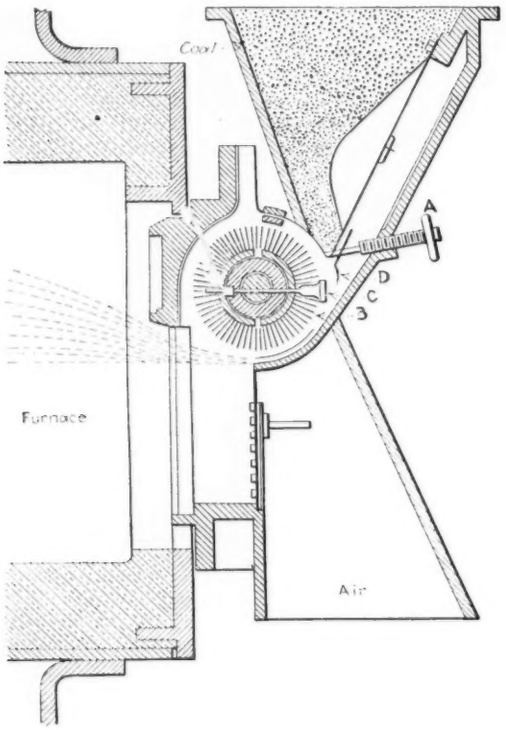


Fig. 3—Schwartzkopff stoker

It is recognized, however, that it may be more or less difficult to find well-qualified men to operate furnaces, but with sprinkling-machine firing methods the boiler tender should find little difficulty in maintaining a proper fuel bed.

Going further, the sprinkling system of coal feeding can be adapted to an inclined-grate stoker, with movable grate bars for working the fuel bed and ash down to the dumping position. Such stokers are now in successful operation, but they are still feeding the small anthracite in at the top of the incline grates. Considering another possible adaptation, little difficulty would be found in using a chain-grate stoker in connection with this sprinkling system of feeding coal by stopping off the supply of coal at the front end of the grate surface and placing the sprinkler feeding device above the present coal inlet. By this arrangement a greater percentage of the fuel-bed surface would become efficient heat-producing area and the fuel would burn from below.

Steam Boilers

A Catechism by Warren Hilleary Served in Small Doses and Extending Over a Number of Issues

62. External corrosion has weakened the head seam of a horizontal tubular boiler. The sheet has deteriorated to a dangerous extent over an area of ten square inches, and the rivets, together with the flange of the head, have also deteriorated to a like amount. A repair is necessary. Would you recommend that the defects be cut out and a patch installed, or would you recommend a new head or a new sheet? If you recommend a patch, how would you suggest that it be applied?

If the corrosion is between the head flange and the sheet, then the defective area should be cut out and a patch installed on the outside. If the rivet holes in such a patch would come so close to any other rivet holes in the sheet as to leave a weak ligament unable to stand the pressure required, a new head will have to be installed. If a new head be installed, then it will be economy also to install a new sheet, unless the rest of the boiler is in such poor condition as to make any repair inadvisable.

63. The rivet holes in a sheet are to be $\frac{13}{16}$ in. when finished. Would you punch them to $\frac{3}{4}$ in. and ream to full size, or would you punch them to full size, or would you drill and ream to full size without punching, and why?

In making a $\frac{13}{16}$-in. rivet hole in thicknesses no greater than $\frac{1}{2}$ in., a $\frac{1}{4}$-in. hole may first be punched, then drilled to full size. Reaming is not essential. Wherever punching is done, the punched holes should be at least $\frac{1}{4}$ in. smaller in diameter than the finished hole.

64. Where is the combustion chamber of a B. & W. type boiler located?

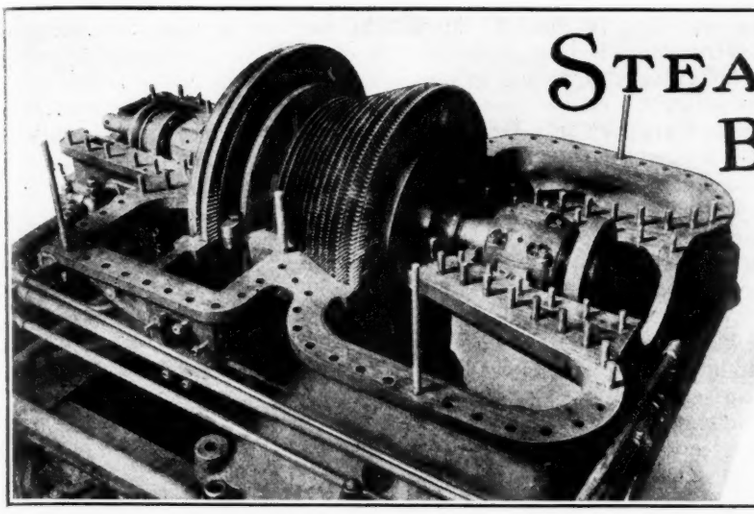
The combustion chamber of any boiler is that space in which perfect combustion is most nearly approached. In a B. & W. type boiler it is probably all the space back of the bridge wall. Because of different methods of air introduction, changing from forced to natural draft, or vice versa, different kinds of fuel used and different methods of firing, the point where complete combustion occurs cannot be fixed definitely.

65. Fire cracks frequently appear on the ends of the rear sheets of tubular boilers and extend from the edge of the rivet hole to the edge of the sheet. This defect frequently occurs in territories where crude oil is used for fuel. A 54-in. tubular boiler is being operated, and it is found that thirty fire cracks exist, approximately half of the number being on either side of the center of the bottom. Would you condemn the boiler because of these defects, and if not, what repair would you recommend?

There are instances where boilers have been operated for several years in this condition, but even if only one fire crack existed it would be advisable to install an entire new sheet. When fire cracks develop, it is an indication that the metal has been burned, not only at the cracks, but elsewhere along the girth seam.

66. What is the difference between a blister and a bag?

A blister is a raised place on one side of a section of metal, the opposite side of which may be undisturbed, and the plate laminated, a bag is evidenced on both sides of the metal, the inner surface of the bag conforming to the outer surface.



STEAM TURBINE BLADING

Reaction Vanes *with* Radial and Axial Clearances

Reaction-type blading in turbines manufactured by the Allis-Chalmers Company, is characterized by the use of shroud rings, which may be arranged to maintain either a close radial clearance or axial clearance. Blade fastenings are tightened in undercut holding grooves by means of calking strips. This is the final article of four on turbine blading.

STEAM TURBINES built by the Allis-Chalmers Manufacturing Company are of the reaction type and the blading is characterized by the use of shroud rings surrounding the blade tips. For many years close radial clearances were depended upon to prevent leakage of steam past the blade tips, and this was accomplished by the use of shrouding of a "U" or channel shape, as in Fig. 2. This type of shrouding made possible the use of much smaller clearances than could have been employed with blading of uniform section not equipped with a shroud ring as the accidental contact or rubbing of the thin edges of the channel did not result in damage to the blading as would have been the case if the blade tips had been unprotected.[1]

Axial Clearances Closer than Radial

In order to obtain further reduction of leakage and consequent increase in economy a new method of baffling was adopted some time ago, in which one of the flanges of the channel shroud is extended in a direction parallel to the axis of the spindle, making an L-shaped shroud ring instead of a channel shape. With this type of shrouding, as in Fig. 1, the clearances are adjusted in an axial direction between the edge of the shroud ring and the cast foundation ring of the adjacent blading. The unit can thus operate with smaller clearances than is possible with radial baffling, which may be affected by vibration, whipping of the turbine shaft and slight distortion of the turbine cylinder due to high temperatures. None of these difficulties materially affects the axial clearance. The stiffness of the rotor precludes any great variation in clearance due to whipping or vibration. This clearance therefore can be safely reduced to about that allowed in the balance piston. This as a general rule, is from one-third to one-fourth of the radial clearance that was formerly employed.

The shrouding construction in connection with this blading not only makes possible the use of closer operating clearances and serves as a safeguard against damage to blading by slight accidental contact, but it materially strengthens the blade structure. The structure is still further reinforced by the use of lacing wires brazed to the blading at a suitable distance from the foundation ring. As a result there is an extremely high natural period of vibration in the blading sections, and recent experiments have shown that this period is in the neighborhood of seven times the normal operating speed of the unit. This reduces to a minimum the possibility of vibration being set up in the blade rings in synchronism with the vibration corresponding to the operating speed of the unit.

The present standard of blading construction also

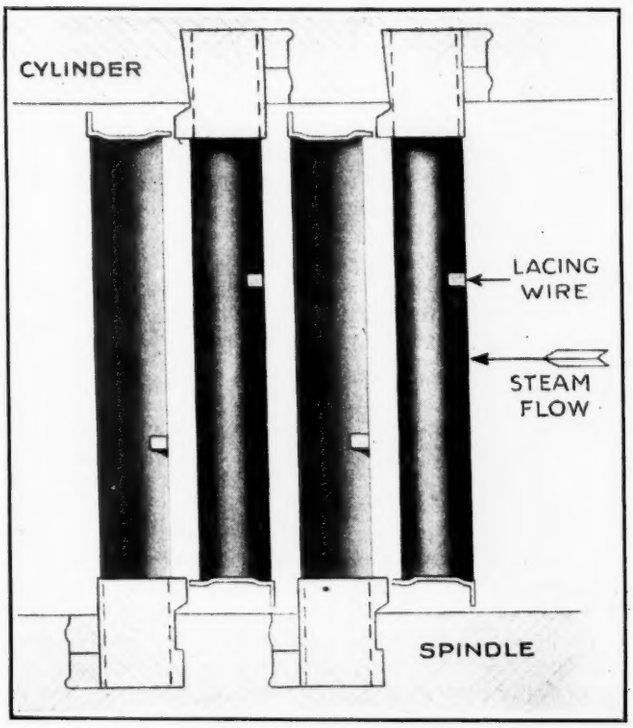


Fig. 1—Close axial clearances shown between shroud rings and adjacent foundation ring

[1]Blade tips that are thinned out or "profiled" in order to prevent appreciable damage from rubbing are described in the Feb. 19 issue.

incorporates a method of fastening the blades into the foundation rings, which is superior to any construction heretofore used by the Allis-Chalmers Manufacturing Company. In this method of assembling, the separate blades are not distorted or bent in any way, but are held by casting the bronze foundation material around the roots of the blades. The process results in a complete bond between the blading material and the material of the foundation ring. The complete blading section, Fig. 1, is provided with a projection on one side, shaped to fit an undercut dovetail groove in the cylinder and an undercut shoulder in the spindle.

The section is held in place by means of calking strips, as shown in Fig. 1. These strips are opposite to holding undercut grooves. In this way the calking strip serves merely to hold the blade section in position in the undercut groove, and the projection serves to hold the section locked in place against centrifugal force. Shroud rings and lacing wires are fastened by brazing to the blades.

Rebladed Accomplished by Renewing Calking Strips

Blading of this kind may be readily renewed by removing the calking strips, inserting new sections and recalking. When structures are to be rebladed in the factory, the calking strips are removed by means of a lathe or boring mill. In the field, however, it is customary, if shop facilities are not available, to remove the calking strips with hammer and chisel.

The new type of shroud ring is used in the high-pressure stages of the turbine only, for the purpose of maintaining a minimum axial clearance instead of larger radial clearances. Steam leakage in the high-pressure end of the unit has the greatest effect on the economy, as it is at this point that the ratio of the clearance to the blade opening is greatest, and also the steam is at its greatest density. With this axial clearance construction it is, therefore, possible to reduce the clearance in this stage of the unit to a minimum and correspondingly increase the over-all efficiency of the machine.

At the lower stages of the machine, where the steam is not so dense and its volume is enormously increased, the older type of radial baffling is employed. The longitudinal expansion of the spindle and cylinder here makes it more difficult to employ the axial clearance construction and the problem of steam leakage is less important. An article published in the May 29, 1923, issue, describes a 5,000-kw. Allis-Chalmers turbine utilizing the axial clearance blade structure and shows the efficiency resulting from this type of baffling.

Axial Clearances Ground Uniformly

In order to adjust the axial clearances to a minimum, the baffling strips on the shroud rings are ground in after the turbine is assembled. This is accomplished by revolving the turbine spindle slowly and bringing the edges of the shroud rings periodically in contact with the corresponding foundation ring sections, resulting in a slight rubbing and wear at the high spots. In this manner these high spots are gradually reduced until the clearance throughout is uniform. After this is properly accomplished, the rotor is backed away in the opposite direction until the desired operating clearance is obtained. This clearance varies from 0.006 in. to 0.015 in. depending on the size of the unit.

The older type of blade with radial clearance appears in Fig. 2. It will be seen at *B* that the clearance is least from the end of the channel-shaped shrouding to the cylinder of wheel casing. At *A* the radial clearance extends from the channel shroud to the spindle or rotor. Leakage is comparatively less important with longer blades, as in the lower-pressure part of the turbine where radial clearances are employed, as before explained.

Blading Materials

The blading has been manufactured for a long period of time, of a copper-nickel alloy, but some monel-metal blading is now applied where conditions of service are exceptionally severe. Other blading materials are being

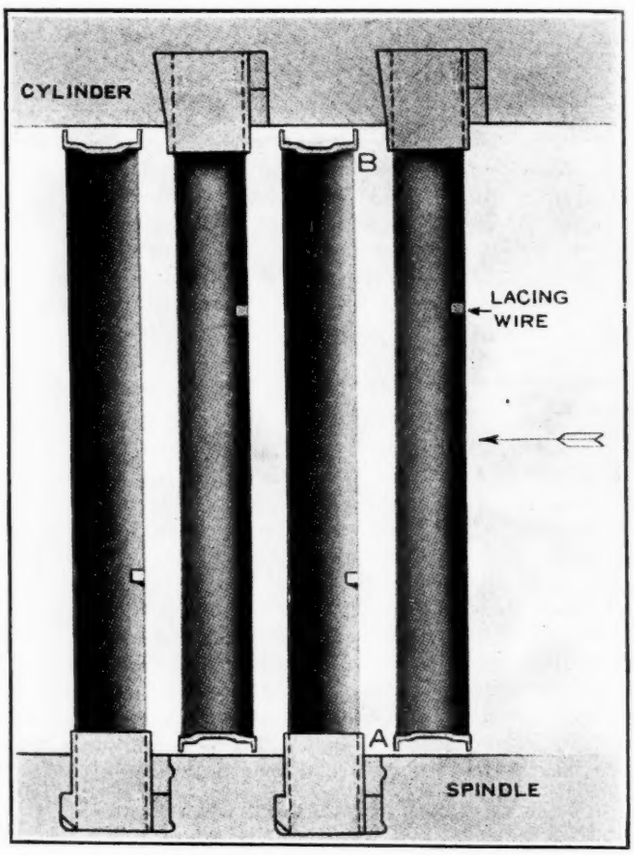


Fig. 2—Radial clearances with channel-shaped shroud rings as used in lower pressure stages

investigated to determine if something more suitable may be obtained for higher temperatures. The blading material is drawn or rolled into long strips of the required cross-section, and these are cut up into the various lengths as suited to manufacturing purposes.

It sometimes becomes necessary to inclose direct-current generators for the prevention of noise or for the purpose of securing clean air for ventilation. There is an objection to inclosing the commutator; sparking or worn-out brushes may escape the attention of the operator. The commutator operation, however may be inspected if a door or window is provided for this purpose. A long narrow commutator may possibly be improved, as far as operating qualities go, by properly inclosing it.

Reconnecting Direct-Current Armatures —Wave Windings

Two-Layer Wave Windings as Used on Drum-Type Armatures — Comparisons Made Between Lap and Wave Windings—Effects on Speed and Voltage When Windings Are Reconnected

By A. C. ROE
Shop Superintendent, Detroit Service Department, Westinghouse Electric & Manufacturing Company

IN A single-lap or parallel winding there are as many circuits as there are poles, while in a single-wave of series winding there are only two circuits irrespective of the number of poles. The leads from the coils in a single-lap winding connect to adjacent segments

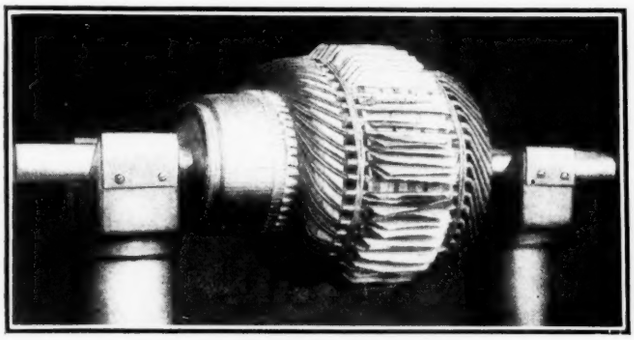


Fig. 1—Wave-wound armature

as in Fig. 2; for example, the leads of coil 7 connect to segments 7 and 8. In the wave winding the coil leads connect to commutator segments that are approximately two pole spaces apart. In Fig. 3, which is a wave winding of 25 coils connected for four poles, the coil leads are connected to points on the commutator that are 12 segments apart; for example, coil 7 connects to segments 1 and 13.

With the lap winding, as was explained in the previous article (Feb. 12 issue), the coils in any one circuit lap over each other. In Fig. 2, starting from the brush on segment 1 one circuit is through coils 1, 2, 3, 4, 5 and 6 to the brush segment 7. It will be seen that the coils lap back over each other, and it is for this reason that this arrangement of the coils is called a lap winding. A wave winding gets its name from the way the coils in a circuit give the idea of waves. For example, in Fig. 3, starting at the brush on segment 7, one circuit is through coil 13 to segment 19, then through coil 25 to *l'* and *l* to segment 6, then through coils 12, 24, 11, 23, 10, 22, 9, 21, 8, 20 and 7 to segment 13. In tracing this circuit out first through a coil on one side of the armature and then through a coil on the other side, one is given the idea of a wave motion.

Instead of laying out the winding as in Fig. 3, it may be represented by a diagram Fig. 4. In Fig. 3 the coils are shown exactly as they would be in an actual winding but laid out flat. If the winding were rolled up to form a cylinder, coil sides *A*, *B*, *C*, *D*, *E* and *F* will fall into slots *A'*, *B'*, *C'*, *D'*, *E'* and *F'* respectively, which would be the arrangement of the coils on an armature. Leads *a*, *b*, *c*, *d*, etc., would connect to leads

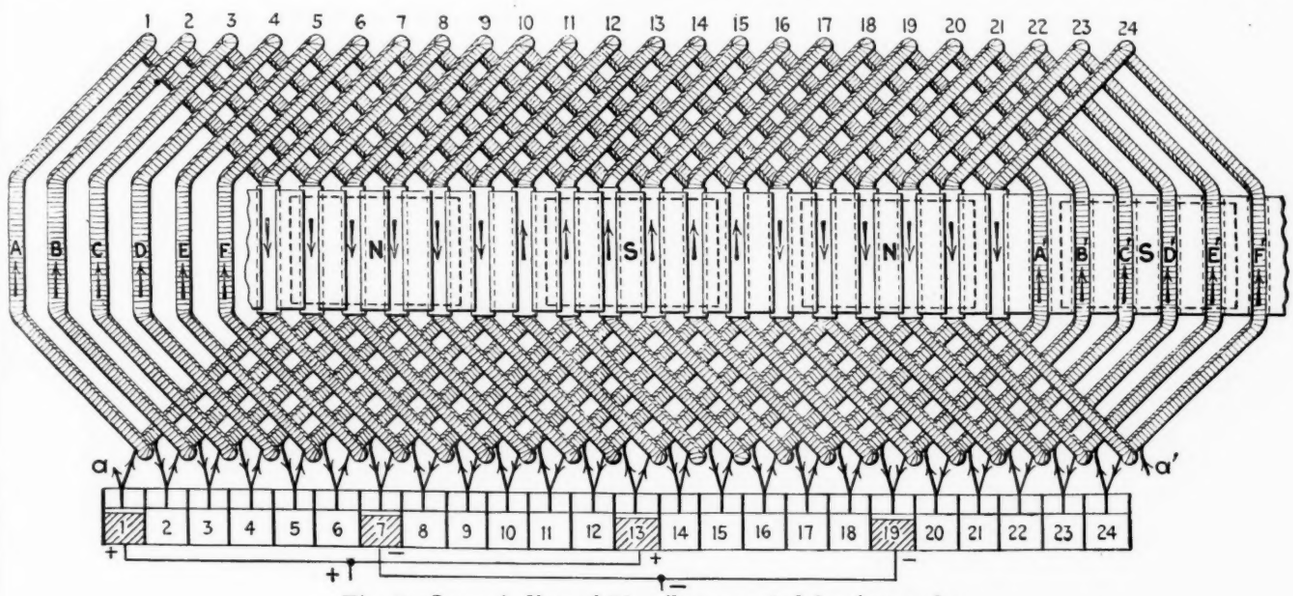


Fig. 2—Lap winding of 24 coils connected for four poles

a', *b'*, *c'*, *d'*, etc., respectively, thus completing the circuit. In Fig. 4 only one turn per coil is shown, but represents the connections and circuits in the winding as effectively as does Fig. 3. For example, starting

from the brush on segment 7, one circuit is through coils 13, 25, 12, 24, 11, 23, 10, 22, 9, 21, 8, 20 and 7 to segment 13 just as in Fig. 3. In Fig. 4 the sides of the coils shown in full lines are the tops and the bottom sides are indicated in dotted lines. Fig. 5 is a counterclockwise direction, where at the back end of the armature the top half of the coil ends bend in an opposite direction, and this is what occurs in Fig. 4.

In a single-wave winding only two brush-holders are required, but as many brush-holders as there are poles

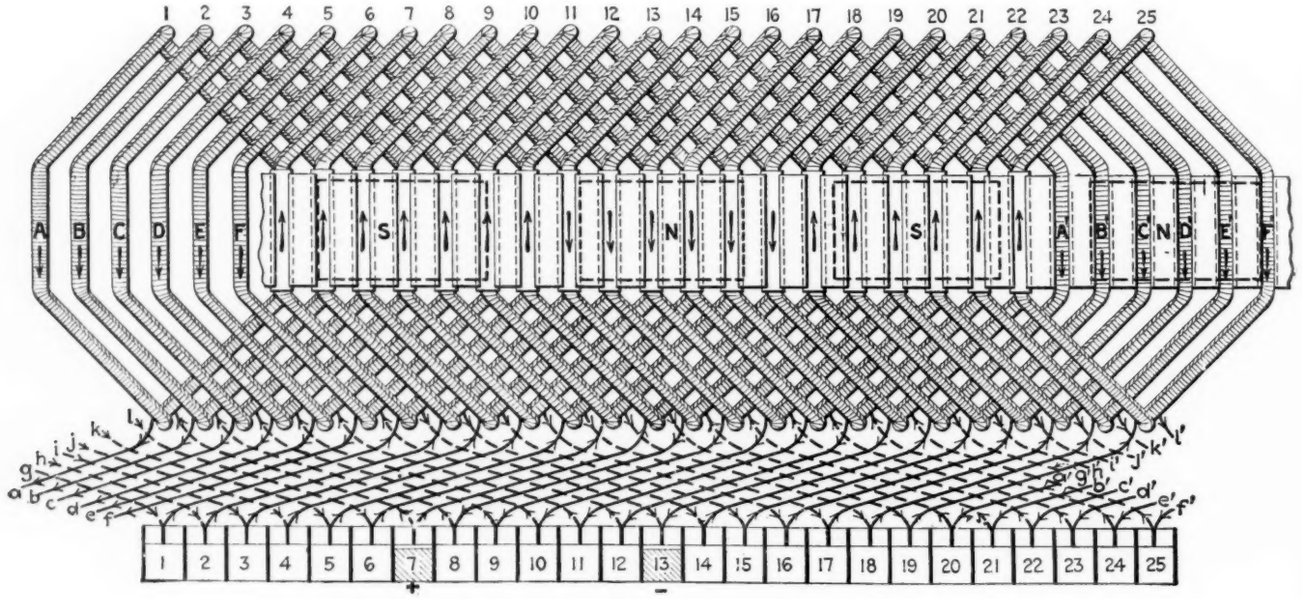


Fig. 3—Wave winding of 25 coils connected for four poles

the same as Fig. 2, but shows the winding in a single-line diagram. Comparing Figs. 4 and 5, it will be seen that the leads of the coils, Fig. 4, bend away from the center of the coil, while the leads of the coils Fig. 5 can be used. The coil leads bend away from each other, and the distance between leads is governed by a formula. A series of coils equal to one-half the number of poles are connected to the commutator in such a manner

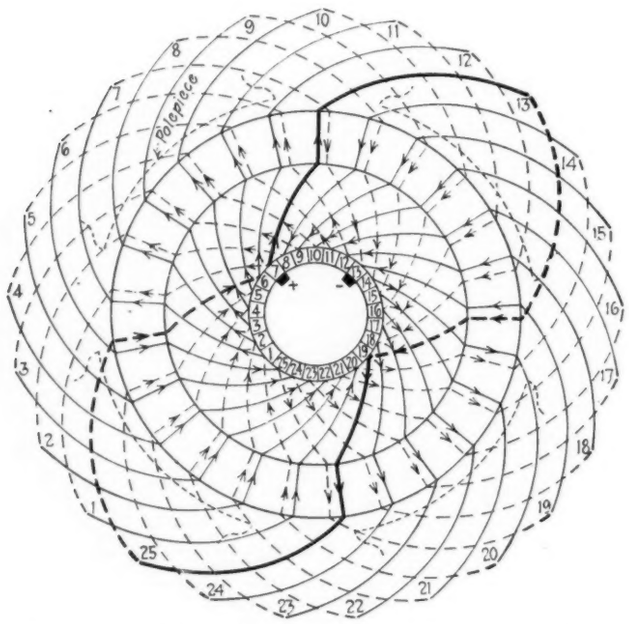


Fig. 4—Winding, Fig. 3, shown in single-line diagram

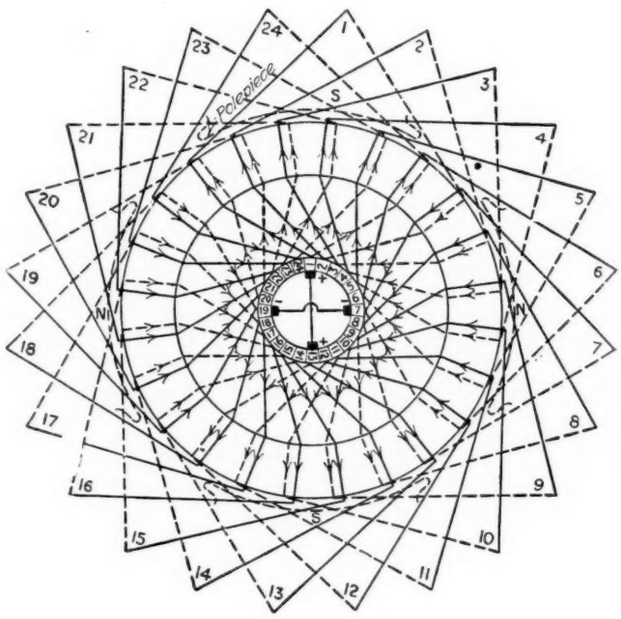


Fig. 5—Winding, Fig. 2, shown in single-line diagram

bend in toward the center. This is one of the distinguishing features of the two types of winding and may be used to recognize one from the other in practice. In Fig. 1, which is a wave-wound armature, the coil leads coming down to the commutator bend around in as to end either one bar ahead or one bar behind the bar on which the series started. It is this fact that determines the number of commutator bars and coils that can be properly connected into a wave winding. In Fig. 4 one series of two coils is shown in heavy

lines. The series starts at bar 7 through coil 13 to bar 19 through coil 25, to bar 6 or one bar behind the starting point. It will be noticed that passing through any two coils in series carries the circuit once around the armature.

When the series of coils $\frac{P}{2}$ (P equals number of poles)

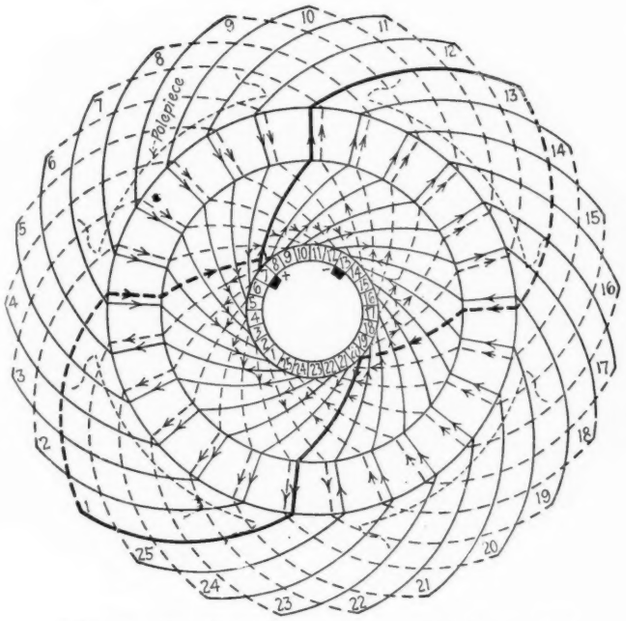


Fig. 6—Winding, Fig. 4, connected long pitch

ends one bar behind the bar started on, the grouping is called retrogressive or a short-pitch winding, which is the case in Fig. 4. Fig. 6 shows the same winding connected up with a long pitch forming a progressive winding. A wave winding is termed progressive when the series of $\frac{P}{2}$ coils ends one bar ahead of the one started on. Thus from Figs. 4 and 6 it can be seen that there are two lead pitches possible on a four-pole wave-wound armature, with the same number of bars and coils, both forming a single-series winding. A four-pole machine is the only one in which a long and a short pitch are possible with the same number of commutator bars and coils; on the six- and eight-pole machines the number of bars would have to be changed to change a given winding from retrogressive to progressive or vice versa.

No equalizer or cross-connections are required on single-wave windings owing to the fact that conductors of equal potential, equally spaced around the armature, are connected together to form the series of $\frac{P}{2}$ coils.

The number of commutator segments and coils in a single-wave winding must not be a multiple of the number of pairs of poles, for if this were the case, the series of $\frac{P}{2}$ coils would close on itself the first time around the armature. A single-wave winding must satisfy the formula, $B = \frac{YP}{2} \pm 1$, where B equals the number of bars in the commutator; Y the coil-lead pitch, which must be a whole number of bars; P the number of poles; and the sign $\pm$ means plus or minus as the case requires. Lead pitch $Y = \frac{B \pm 1}{S}$ where S equals pairs of poles. Then for Fig. 4, $Y = \frac{25-1}{2} = 12$; that is, the lead pitch is bars 1 and 13; this is the short pitch. For Fig. 6, $Y = \frac{25+1}{2} = 13$, or the lead pitch is bars 1 and 14. When talking of lead pitch, we say the leads connect to bars 1 and 14, or 1 and 8, etc. Therefore, when using the foregoing formula, always add one to the value obtained, and say one and the sum found as the cases may be.

An interesting use of this formula came about when changing a six-pole machine from 125 to 250 volts. The armature had 100 bars which connected up into a single series, $Y = \frac{100-1}{3} = 33$, or a lead pitch of 1 and 34. Then, as twice the voltage was required, it was thought that twice the bars would meet the new conditions. As the machine was strap wound with one turn coils two straps in parallel, it was intended to reinsulate these straps to give twice the number of coils. On applying the formula to 200 bars, it was found that this number would not connect into a single-series short-pitch winding, as $Y = \frac{200-1}{3} = 66\frac{1}{3}$, which could not be used; but that a long-pitch winding could be used, as $Y = \frac{200+1}{3} = 67$ or a lead pitch of 1 and 68. A 200-bar commutator was ordered and one coil left dead, which made $Y = \frac{199-1}{2} = 66$, or 1 and 67 short pitch. When the minus sign

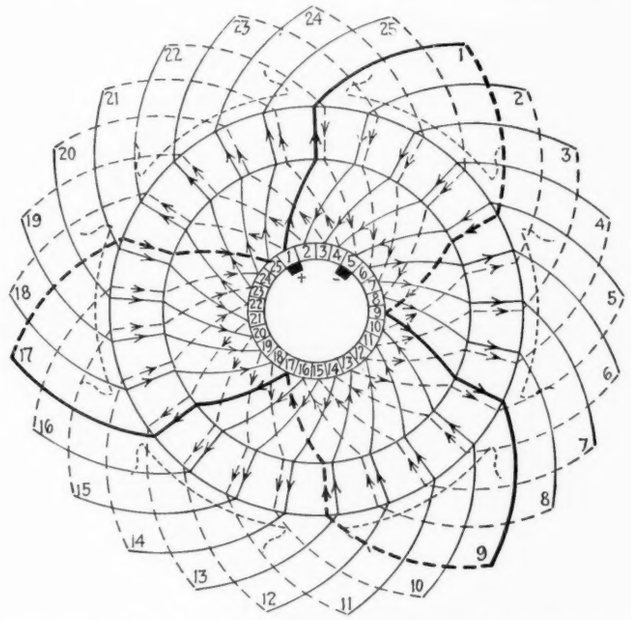


Fig. 7—Wave winding of 24 coils connected for six poles

is used in the formula, the winding will be retrogressive, or short pitch, and when the plus sign is used, the winding will be progressive, or long pitch. In this case the short-pitch winding was used so that the armature would run in its original direction. Changing from a short to a long pitch changes the direction of

rotation of a motor with the same external connections. Why this is will be made the subject of another article.

In some cases when a change is made from a lap to a wave winding, the number of coils and commutator bar may not satisfy the formula. One instance in mind is that of a four-pole lap winding having 98 coils and

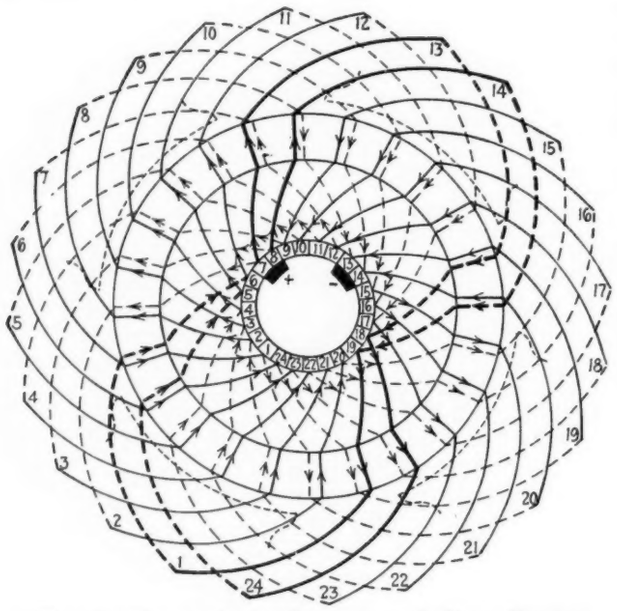


Fig. 8—Four-pole double-wave winding diagram

commutator bars. Changing to a wave winding, $Y = \frac{98-1}{2} = 48\frac{1}{2}$ or $Y = \frac{98+1}{2} = 49\frac{1}{2}$, which indicates there is one bar too many in each case. $Y = \frac{97+1}{1} = 49$ or the lead pitch is 1 and 50; long pitch, or $Y = \frac{97-1}{2} = 48$; that is, the lead pitch is 1 and 49, short pitch. In cases like this the extra bar may be eliminated by connecting two together and using them as a single bar and leaving one coil dead in the winding. Thus it is possible, when changing from a lap to a wave winding, to adopt the lap-winding bars to satisfy the wave-winding formula.

Fig. 7 shows a six-pole single-series wave winding. The number of commutator bars, $Y = \frac{25-1}{3} = 8$, or 1 and 9, short pitch. The series of $\frac{P}{2}$ three coils, is shown by the heavy lines. This winding has only two paths, as can be seen by starting at any positive brush and tracing through to the negative.

Fig. 8 shows a four-pole double-series (four-path) winding. In this connection the series of $\frac{P}{2}$ coils will end two bars ahead or behind the starting bar. The two series of coils shown in heavy lines clearly indicate that the beginning and ending of the series are two bars apart. In a double-series winding the brushes must cover at least two bars, and the winding must satisfy the formula $Y = \frac{B \pm 2}{S}$, in Fig. 8, $Y = \frac{24-2}{2} = 11$, or 1 and 12, short pitch. Y could be $\frac{24+2}{2} = 13$, or 1 and 14, long pitch.

A four-pole lap-wound armature will have four paths, a six-pole, six paths, eight-pole, eight paths, etc. Then as a wave winding has only two paths regardless of poles, it follows that if a four-pole armature is changed from lap to wave, the number of conductors in series will be doubled and the armature will be good for double its original voltage but one-half the current. If a four-pole wave winding is changed to lap, the number of conductors in series will be reduced one-half and consequently the voltage the armature will be good for, but the current-carrying capacity will be doubled. Since the current capacity of the armature varies inversely with the voltage, the power rating remains constant.

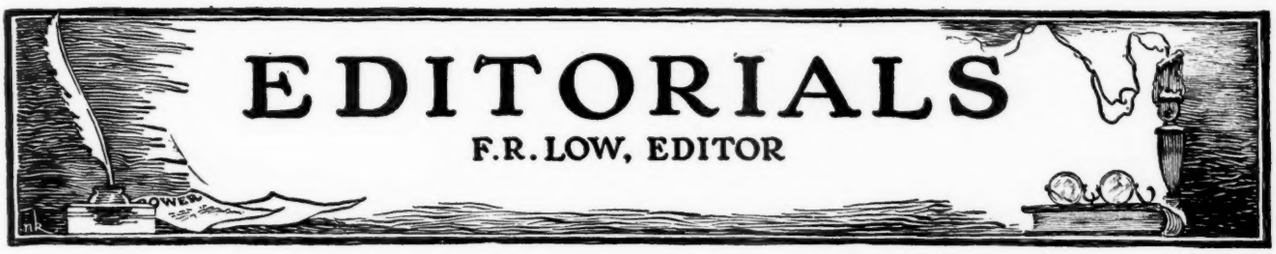
On a six-pole machine changing from a lap winding (six-circuit) to single wave (two circuits) the total turns in series will be tripled, or a 110-volt lap winding would be good for $3 \times 110 = 330$ volts wave wound. Changing from wave to lap reduces the number of turns in series one-third, likewise the voltage, but increases the current-carrying capacity three times.

An eight-pole lap winding (eight-path) changed to wave (two-path) would increase the turns in series four times and make the winding good for four times the voltage, with current-carrying capacity reduced one-fourth. Changing from a wave to lap winding would decrease the turns to one-fourth the original and increase the current capacity four times. This also applies to machines with a greater number of poles, but the ratio would be 2 to 10, 2 to 12, etc. When making these changes, the current-carrying capacity of the brushes and the voltage between commutator segments must be considered.

In connection with wave windings the term dead coil is quite often found. This means that one coil is cut out of active service, so that the correct number of bars can be used. For example, an armature with 47 coils and bars wound for 110 volts was to be reconnected for 220 volts. The winding had four double turns of two No. 10 wires in parallel, or four wires per bar. Now, 47 bars satisfies the formula for a single-wave winding, but when the armature is wound for 220 volts by using 94 coils of four turns of single wire, a new commutator is required. However, 94 bars will not connect but 93 will, therefore a 93-bar commutator was used. Both leads were cut off one coil and this coil left dead in the winding, making a total of 93 active coils and bars.

While the foregoing is not a complete study of the various styles and forms of direct armature windings, the rules given do apply to the modern direct-current machines and will cover ninety-nine cases out of a hundred.

The air receiver should be as near the compressor as practicable, and there should be a separate pipe from each compressor to the receiver. The practice of connecting a battery of compressors to a long header pipe leading to a receiver outside the building is not good. Under certain conditions this produces pressure surges in the air moving down the long pipe, which materially increases the power required to drive the compressor. These surges require energy to produce and, as they serve no useful purpose, are a direct waste of power. It is better to have a receiver for at least every two compressors and each machine connected through a separate pipe of its own, the piping to the receiver being as short as possible and full size of the compressor outlet.



Progressive Engineering in Grand Rapids

THE mere fact that a 4,500 kilowatt municipal central station which disposes of its exhaust steam for industrial purposes and heating will soon be in operation at Grand Rapids, Michigan, means little to the engineering world so far as magnitude of power production is concerned. However, as a straw to indicate the trend of the wind typifying fuel conservation, this installation should not be overlooked.

An efficient cycle for the production of energy is in many cases, the complete answer to the problem of the large plant. Nevertheless, energy so generated cannot compete thermally at present with that from a less efficient plant utilizing, at reasonable returns, the exhaust heat energy. In view of the relatively large amount of wasted exhaust heat in the most efficient plants of today, there is a growing conviction that the intensive search for cyclic efficiency will yield more and more to that for broader fuel economy.

Does it pay to furnish heat and power in combination? Grand Rapids evidently thinks so. They have operated a heating plant for this territory since 1886. Perhaps the reason lies not so much in the fact that 350-lb. 200-deg. superheated steam will be supplied the turbine, and that heating steam in three pressure ranges, of approximately two, eight and one hundred pound will be furnished, but rather to the condition that an all-year demand for steam is secured by means of industries close by.

The great lesson in this instance seems to be that the progressive engineering of the future will be required to adjust the utilization of fuel for a community, rather than the energy production for a number of smaller groups. This may involve the arrangement, to some extent, of a community itself so as to suit the efficient utilization of power and heat.

Architects and Engineers

THE work of the architect is peculiar in that it requires both artistic and engineering ability, a combination rarely found in a single individual. Most architects have a personal leaning one way or the other. The more successful associate with themselves men who are strong where they are weak.

Only a superman could be fully competent to decide personally all the questions that arise in the construction of a variety of important buildings. The wise architect realizes that a structure, to do him full credit, must be beautiful, durable, convenient, well heated, lighted and ventilated, reasonable in first cost and in operating cost. Most architects are competent to insure the beauty and the durability. The heating, lighting and ventilating usually require the assistance of technical specialists in these subjects. The architect generally understands this. He also is generally willing to let a specialist lay out the equipment of the boiler room and engine room. The trouble is that the power-plant engineer is not usually called in until after the space for the plant has been unalterably fixed without any regard for the requirements of safe and economical operation.

Anyone who has much contact with the operating engineers in office buildings and public buildings, particularly in the more congested centers, will find an undercurrent of feeling against the architect. In spite of the marvelous achievements of our architects, one can hardly blame the operating engineer. What matters it to him that the building has a perfect Gothic spire if his boilers are tucked into a cubby hole with a two-foot clearance over the drum and with no room for tube removal without making holes in the wall?

It is not reasonable to expect architects to become capable power-plant engineers, but they should learn that a proper plant cannot be slipped into any hole in the ground. The space should be fitted to the plant. The power-plant engineer should be called in during the early stages of the design and not asked to distort his plant into some ridiculously unsuitable space.

Improvements in the Mercury Boiler

THE installation for commercial operation of a mercury boiler and turbine installation at the Dutch Point station of the Hartford (Connecticut) Electric Light Company has aroused the curiosity of the entire world of power-plant engineering as to the results of the first few months' service. At this time only preliminary and informal comment can be advanced in regard to this service, but it is well understood that the Hartford experiment is proving encouraging; that the fuel economy of the initial outfit is running under favorable conditions around thirteen thousand or less B.t.u. per kilowatt-hour, and that far less difficulty is being experienced in the development of this apparatus than was encountered in the development of the steam turbine on the premises of this same progressive central-station organization many years ago.

Already a total of something like seven hundred and fifty hours of commercial operation has been credited to the Hartford installation. There have been a number of shutdowns, but it is a singular and encouraging fact that these have been largely, if not entirely, due to troubles having no direct connection with the mercury vapor process. Ten years of profound engineering research by Mr. Emmet and his assistants at Schenectady lie behind this pioneer commercial installation, and it is interesting to learn that the transfer of the process from the factory to the Hartford plant resulted in performance largly as anticipated. Certainly, troubles due to the failure of generator collector rings, to the break-

down of oil-switch bushings, to unsuitable valve equipment on the steam side of the apparatus, and to the misbehavior of standard-type governor apparatus, while causing shutdowns of equipment, cannot be debited against even so newly hatched a power producer as the mercury boiler and turbine!

The trend of future design indicates the use of a sectional mercury boiler permitting a well-scheduled maintenance and inspection program. Preliminary experience indicates that fears as to the excessive wear of turbine blades are groundless. The problem of leaks seems to be in a fair way to be completely solved, and in fact, it is said that this has given very little trouble. Without arc welding the mechanical details would have been most difficult to carry out, and high praise must be accorded to the designers of this installation for their versatility and practicability in producing new and unique means like the accordion joint and type of governor utilized, to say nothing of the mercury vapor condenser developed to meet the conditions.

It is a wonder that the apparatus has worked at all, considering the number of new details embodied in it, and the results are a real tribute to the men responsible for them, and testify anew to the value of a searching knowledge of theory combined with great practical skill in construction. The multi-stage turbine offers further possibilities, and the decreased amount of mercury to be required in future work has a direct bearing upon the success of the development. The apparatus is intensely interesting, and authoritative detailed statements of its performance are eagerly awaited.

Back to Fundamentals in Condenser Designs

WHILE engineers rather pride themselves on being swayed only by hard cold facts, in truth there is a lot of drifting with the crowd in power-plant design. This is especially true with respect to some of the important parts of a plant, such as ammonia condensers.

Early in the development of the art of mechanical refrigeration the atmospheric type of condenser was in almost universal use. The spraying or pouring of water over the exterior of a coil in order to remove heat from the gas contained within was simple and appealed to those pioneers whose aim was to make a workable system without undue complication. That liquids flowed down hill was understood even by the layman, and so it causes little wonderment to find that the ammonia gas was led into the coil at the top and the liquid drawn off at the bottom.

Engineers were not satisfied with this extraordinary simple condensing device, and with claims of greater heat tranfer, less water and others, a great many types have been built and put into service. So strong has been this drift that the atmospheric downward flow condenser is seldom found in modern plants, its place being taken by flooded, bleeder, upward-flow or double-pipe units.

Recently, the head of a large ice-machine manufactory, in an address at a meeting of refrigerating engineers, stated that a large number of tests had shown the downward-flow principle to be the most satisfactory within either atmospheric or double-pipe condensers. It is time that some halt be made to the fancies of the designer.

Along with the weird condensers had grown up a belief that since ammonia vapor is heavier than air, the air and other foreign gases will seek a resting place in the top part of the condenser. Little thought has been given to the fact that the air and ammonia vapor are in effect a mixture and are not separated. The system of top purging has entailed the loss of millions of pounds of ammonia which loss could have been avoided by a better appreciation of the laws of gases.

It has been definitely determined that the proper location of the purge valve is on that part of the condenser where the ammonia is coldest, which usually is at the exit. In view of the tests mentioned it would seem that a large loss could be avoided if engineers would at once take steps to relocate the purge and to remodel the condenser to permit the gas to enter the condenser top and the liquid to drain away at the bottom.

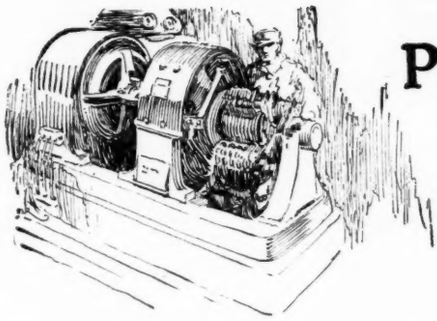
Some More High-Sounding Statements

AT A recent meeting of the Public Ownership League of America, Rev. J. A. Ryan, D.D., said: "Public superpower would reduce the cost of electric service at least one-half; it would make electricity cheaper than gas, oil or wood; it would make possible hundreds of new industries and greatly increase the productive power of those now in operation; it would double the carrying capacity of railroads, with a corresponding reduction in cost of transportation."

Senator George W. Norris, speaking before the same organization, said that he believes that "there are unlimited scientific possibilities and that it is only a question of a very short time before some one will invent a storage battery that will make unnecessary the transportation of coal for purposes of heating and power. One wire will then take the place of thousands of coal cars. This will settle the question of gasoline and coal."

To the engineer who is familiar with the problems of power generation and distribution, these statements are the wildest absurdities, but to the average layman they lead to expectations that never can be realized and may result in detrimental consequences to the whole power industry. Public interest in these problems is desirable, and if the industry is to contribute its full share to modern civilization, such an interest is indispensable; but it must be based on sound doctrine and not on high-sounding statements or statements that are impossibilities unless the present methods of power generation and distribution are replaced by some new developments of which we know nothing at present and of which there is only the remotest hope.

The possibilities of our modern power generation, transmission and distribution systems need no embellishing with false doctrines and impossibilities to be justified in the minds of the public. The most hopeful expectations of only twenty-five years ago have already been surpassed. One of the greatest needs is to set forth the facts in unmistakable terms. This is the province of the engineer, and up to the present time he has failed to do this part of his job. He has been eminently successful in a few years in producing something of first importance in our modern civilization and without which the present high standards of living could not exist, but he has been derelict in setting forth the facts of his achievements to the layman. To prevent the public from being misinformed on the accomplishments of electric power is one of the ways that the engineer may take a greater activity in public affairs.



Practical Ideas *from* Practical Men

Bonus System for Firemen

To secure the best results, a bonus system should be based upon the following points, in the order of greatest importance: (1) Water evaporated per pound of coal; (2) percentage of air excess in the flue gas as indicated by the CO_2; (3) temperature of the flue gas on each boiler.

Inasmuch as the plants with a large number of small boilers do not as a rule find it advisable to install all the necessary instruments to secure the desired data just enumerated, we must develop a sensible every-day plan which will eliminate the complicated array of various instruments which would require too much additional labor for maintenance.

With all due respect to the engineers that advocate the continuous test, my fourteen years of experience in testing boilers and the operation of steam power plants does not prove to me that a continuous test is practicable.

The prime essentials in securing economy and good service in the steam plant are as follows: (1) The condition of the equipment; (2) the quality of the men, that is, their loyalty to the company and ability to secure results; (3) the quality of the coal.

Before we start a drive for economy, we must have the stokers, boilers and auxiliaries in good repair so that the operating men cannot blame their troubles upon defective equipment.

The importance of securing the best quality of coal for the money and, if possible, a coal that is best adapted to the stokers installed, is conceded by all engineers. It is usually advisable to purchase a free-burning coal that will produce a high boiler capacity for the heavy-load periods of the year rather than to fire up and operate additional boilers. A cheaper coal can often be used with good results during the periods of light load, and in plants where the bulk of the steam is used for heating it can be used to advantage during the summer months.

We will take it for granted that the equipment will be put in the best possible condition and that the proper kinds of coal will be purchased to secure the best results in service and in economy; therefore, our maximum efforts must be directed toward improving the quality of the operating personnel—the firemen and their helpers.

If the bonus system is applied to the firemen, it should not be given with a view of paying them for their routine duties; it is paid to make their work more interesting and to develop rivalry among them. It tends to develop the individuality of the man, just what the modern plant has been smothering during recent years.

It has often been said, "Why not just pay the firemen that much additional per hour? The money is what they want regardless of how they get it." However, experience has proved that this logic is incorrect. Increasing the hourly rate only serves to improve the efforts of the men temporarily, while a bonus system makes it necessary to earn the increased amount all the time and provides a flexible penalty for falling below the fixed goal.

Experience has shown that it is not always desirable to threaten men with discharge if they do not do this or that. Some of the most successful men have the ability to handle men with but few changes, after they once get an organization developed. A bonus system should cause men to stay rather than to quit or be discharged. Of course, at the outset, when the new systems are being installed, it is admitted that many changes may have to be made to secure men that will be in harmony with the improved methods.

The following plan of applying the bonus system can be used as a starter and enlarged upon as we go along.

1. Apply water meters to record quantity of water evaporated.

2. Make eight-hour tests during the day shift, using these results to check the quality of the coal and the attitude of the firemen.

3. Install counters on the stokers (if underfeed) to ascertain the number of ram strokes. The "law of averages" gives a good idea of the results on night shifts, using the day-test shift as a basis for comparison.

4. Install recording flue-gas thermometers on all boilers to get an idea of operations. The flue-gas thermometer is an inexpensive instrument compared with the CO_2 recorder, the flow-meter or the boiler meter. The average small plant is so carelessly operated that attractive savings are made by watching the load factors of the boilers fired to see that no one boiler is operated with light load while others are overloaded. The greatest losses occur from underloaded or heavily overloaded boilers. The average plant of today equipped with all modern instruments depends more upon the flow-meter indicating a uniform load of 150 to 200 per cent capacity than it does upon all of the other instruments combined.

During the last seven years it has been a common thing to observe that only a few of the boilers were operating at the proper capacity where CO_2 bonus systems were in operation. Some of the plants represented the best that money could buy in respect to equipment, instruments and personnel, yet an installation of flue-gas thermometers on all boilers with results indicated at one central point, under the observation of a practical engineer, would have secured better service and a higher economy, due to a more uniform loading of

the boilers, together with a practical system of cleaning fires such as to prevent several fires being dropped at one time. The recording flue-gas thermometer will tell you if the boiler has been loaded or underloaded, if you have made actual tests on the boilers and are familiar with its characteristics.

5. With forced draft, a recording draft-pressure gage should be installed on each boiler.

In one plant containing 17 boilers with underfeed stokers and a separate turbine-driven fan for each stoker, the greatest loss resulted from the use of excessive wind pressure. The installation of boiler meters practically eliminated these losses.

The bonus, to be most effective, should in my opinion, be paid only under the following conditions:

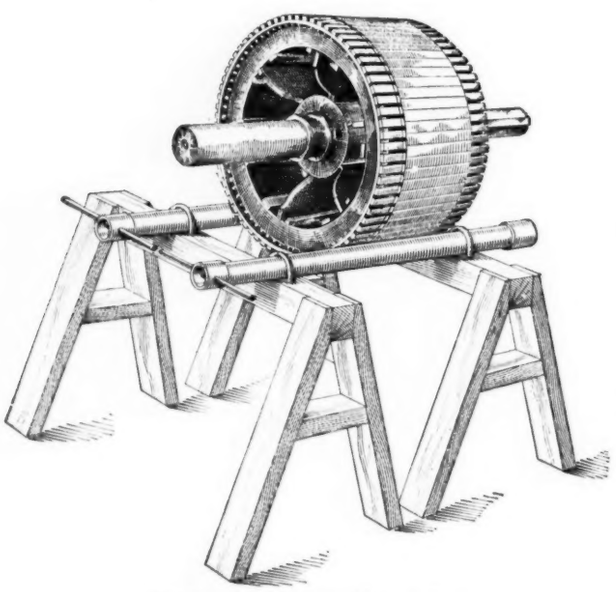
1. That attendance is practically perfect.
2. That the firemen show by their actions that they are working for its success and best results for the company. A few sulkers and knockers will undo all of the efforts of the best men.
3. The maximum bonus should not be less than 10 per cent of the weekly wage.
4. The bonus should be paid only after the man has been employed for at least three months.
5. The bonus should be held back for a period of not less than one month. That is, when the first bonus is paid, the fireman will also have another bonus earned, which he will forfeit in case he should quit.
6. The bonus should be paid in a lump sum in a separate envelope.

WALDO WEAVER.

Tonawanda, N. Y.

Repairing Induction-Motor Rotor

Most of the repair work to be done on an induction-motor rotor is around the end rings where the bars connect. In doing this work it will be found that much



Method of supporting rotor

of it can be accomplished more easily at the bottom side of the ring than from the top, and to make it convenient to work at any point on the end rings and bars, the device shown in the figure, for supporting the rotor, was constructed.

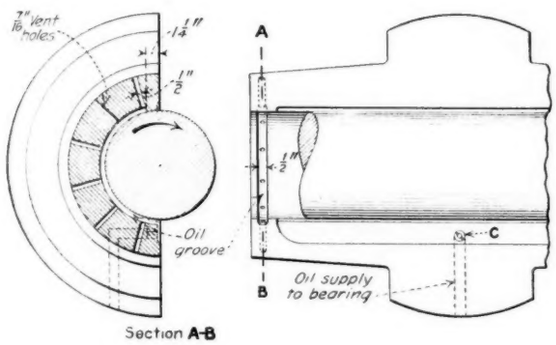
It consists of two ordinary wooden benches with two pieces of 1½-in. iron pipe supported on them. These pipes are held in place by U-bolts in the horses. On the ends of the pipes are placed couplings to prevent them from working back through the U-bolts. Holes are bored through the coupling so that short ½-in. rods can be used for turning the pipe when the rotor is to be moved.

HENRY KLIEBER.

Teaneck, N. J.

Eliminating Oil Vapor from Steam-Turbine Bearings

The tendency in steam-turbine design is to reduce the weight per kilowatt as low as possible. In some cases this results in overcrowding the center main and pedestal bearing into the end bells of the generator, causing



Arrangement of groove and vent holes at end of bearing

the oil vapor to be drawn into the generator, which at all times should be avoided.

In the plant where I was formerly employed several schemes were tried to prevent this discharge of oil vapor, such as circular felt wipers secured to the end of the bearings, at the same time reducing the oil flow to a minimum. Some little improvement was effected, but not sufficient to say the trouble had been cured.

It was decided to alter the design of the bearing by machining a circular groove ½ in. wide coming within a quarter inch of the end of the bearing. This groove extended completely around the top half of the bearing with five 7/16-in. holes drilled through the bearing shell to vent the groove.

In the bottom half of the bearing the groove extended only partly around the bearing surface and ended in a ½ in. hole drilled through the bearing shell 1¼ in. from the bearing joint; five 7/16-in. holes also vent the bottom portion of this oil groove. The leading side of the groove starts in the direction of the rotation of the shaft; any oil in excess is wiped into the groove and discharged through the five outlets in the top and bottom halves of the bearing. The oil is prevented from making a complete circuit by the other end of the groove being blocked and, if carried around, will be discharged out of the ½-in. hole. The oil supply at *C* was also reduced to 5/16 in. in diameter by means of a short bushing at the outlet.

This groove prevents the surplus oil from being discharged under pressure from the end of the bearing. It is only necessary to make this alteration on the outer end of the bearings nearest the generator.

New York City. H. T. MELLING.

Comments from Readers

Distribution of Power Costs Among Departments

Referring to the inquiry of J. W. E. in the Jan. 22 issue, for a practical method of determining power-distribution costs among the various departments of an industrial plant, such determinations can usually be made with a fair degree of accuracy, provided there are means of determining total power consumption.

Practically every industrial plant has its periods, determined by season, market, breakdown, accumulated departmental production or other factors, during which the entire plant is closed down, the operation of a certain department is stopped, certain departmental units are not operating or during which there are different rates of production. If a record of total power consumption be taken under each of the foregoing conditions, as opportunity offers, a distribution can be determined, the accuracy of which is improved as the number of such observations increases.

Periods of plant shutdowns provide opportunities for determining friction loads and for making leakage tests. These items should be distributed to the various departments in the proportion in which they use power.

Copperhill, Tenn. L. V. CURRAN.

Indexing and Filing Articles

While reading the comment by L. W. Lowerre in the Jan. 15 issue, on "Indexing and Filing Articles," it occurred to me that it might be helpful to someone if I should describe my own system for doing this.

To begin with, I consider that although the advertisements are of interest and value for the time being, they are not valuable enough to keep permanently on file. In fact, their great bulk practically prohibits this. For this reason, as soon as I have finished reading an issue of *Power*, I turn back the cover and with a pocket knife remove the staples. It is then an easy matter to remove the advertising sections bodily. All the reading matter, including the cover, is left in its original form.

I preserve all my copies in this manner until the regular six-months' index is sent out. Then I punch three holes in the back of each copy, on the line of the former staples, and lace the whole volume together inside a cardboard cover, with the index in the front of the volume.

The principal objection that I see to Mr. Lowerre's method is that at the time of reading an issue a man can never be sure to what article he will want to refer in the future. Also, there is trouble if he wishes to preserve two articles that appear on the same page but upon different topics. For instance, I never expected to have to refer to an editorial on "Gumption," by Mr. Low, but last week when the necessity arose, I merely had to look in my index, which immediately told me to go to page 279 of the Feb. 20, 1923, issue.

This method gives a neat appearing file. A small typewritten slip attached to the back of the volume gives the volume number and date of the inclosed copies. I think this method takes little if any more time than that of Mr. Lowerre, and the volumes are permanent. The space required is probably larger than by the other method, but is not excessive. The volumes may be kept on a shelf. H. B. HODGINS.

Wilkinsburg, Pa.

Strength of Chains

On page 1041 of the Dec. 25, 1923, issue $P = Kd^2$ is given as the formula for the approximate safe loads to be carried on iron chains, is which d = diameter of stock in inches, K = 11,000 to 13,500 for open links and K = 13,000 to 20,000 for stud links, with the lower values of K for much used chain.

Being thoroughly acquainted with the breaking tests and safe working loads recommended by the American Bureau of Shipping, Lloyds' Register of Shipping, American Society for Testing Materials and by the various chain manufacturers, I suggest the use of the following table as being more up-to-date and in closer agreement with present catalog ratings.

Safe working load = Kd^2, in which d = nominal diameter of stock in inches, or trade size of chain, and values of K as shown in the following table:

Size of Chain (d)	1½ In. and Under	1⅝ to 2½-in
Stud-link chain (iron)	21,500	20,000
Open-link chain (iron)	18,000	17,000
Open-link chain (steel)	15,500	.....

In case of worn chains, the values of K should be decreased in proportion to the amount the cross-section of the chain is reduced at the point of greatest wear. The blank in the table is due to the fact that steel chain is seldom made in sizes over 1½ in.

Bridgeport, Conn. DAVID FLIEGELMAN,
Chain Design Division,
American Chain Co., Inc.

Relative Cost of Live and Exhaust Steam

Referring to the editorial in the Jan. 22 issue entitled "Other Lessons from Mount Hope," I have been deeply interested in the question of relative cost of live and exhaust steam and believe that the figures used at Mount Hope are accurate for their equipment. The plant where I work has similar bleeder turbines, and we figure the cost of bleeder steam as follows:

On our average load of 1,000 kw. the steam consumption of the turbine straight condensing is 18,000 lb. per hour and when bleeding, 10,000 lb. per hour. At 10 lb. back pressure the steam input of the turbine is 25,000 lb. per hour, so, to produce this 10,000 lb. of low-pressure steam 7,000 lb. of high-pressure steam is required, or the cost of low-pressure steam is 70 per cent of that of high-pressure. If this is 50c. per 1,000 lb. for high-pressure, then for low-pressure steam it is 35c. per 1,000 lb. The argument that it is worth just as

much as high-pressure steam because it has as many heat units available is fallacious, for the factory power plant is in the position of a public utility furnishing service at cost and should not attempt to make an unreasonably good showing for one class of service at the expense of another. In some cases low-pressure steam is valued at 33 per cent of the cost of high-pressure steam, but this seems too low.

Figuring the cost of low-pressure steam in this way is applicable to engines as well as turbines, and as to whether it will pay to run the engine with 5 or 10 lb. back pressure and use part of the exhaust, as against free atmospheric exhaust, or to run the exhaust of the engines through the feed-water heater and carry back pressure on the auxiliaries for the process steam. It will be found that the ratio of extra live steam required to low-pressure steam utilized will vary for different load conditions, but for factory accounting work an average percentage of the cost of high-pressure steam determined by tests covering a full cycle of operation, whether a day, week or year, will be the most convenient, this being changed if at any time there is a big change in the cycle of operations and relative consumption of high- and low-pressure steam.

As a rule bleeder turbines do not show any particular gain in economy for bleeding small quantity or at light loads, but as capacity load is approached and maximum extraction is required, the net steam consumption—that is, steam rejected to condenser per kilowatt-hour developed—decreases rapidly and may be only 3 to 5 lb. per kw.-hr. This assumes a very close adjustment of process steam and power demands and is hard to realize in regular operation.

One of the principal causes of failure in using low-pressure steam in process work is making pipes too small to deliver steam as fast as needed, and where steam is blown directly into water, failing to provide a diffuser or ejector to allow of quick and quiet heating without water hammer in the piping. These matters are easily remedied with a little care and are, as shown by the results at Mount Hope, well worth while.

New Haven, Conn. H. D. FISHER.

Starting Ice Machines

The mode of procedure of starting a refrigerating machine outlined by J. C. Lambert, *Power*, Jan. 8, is all right if the compressor is steam-driven, but one would have some more difficulties if the same routine was followed with synchronous motor driven machines.

Suppose everything is running perfectly and the power goes off. There isn't much time to close all the valves he mentions and pump out the discharge line. One is lucky if even the suction valves can be closed before the machine stops. The other valves must be closed after all the machinery has stopped and, if at night, in the dark. The result is that the cylinders have the full head pressure on them when the machine is ready to start again. The seal on the receivers is probably broken because the expansion valves, being open, have been draining the receiver, while no ammonia has been returning to the condensers. The expansion side of the system is, doubtless, flooded, with the back pressure high; and if the gas has been wet coming back to the compressors, the suction header is flooded also.

Synchronous motors will not start with much load, therefore the discharge valves must not be opened before starting if there is much pressure on them. They should not be required to pump gas at more than 35 lb. gage through the bypass when the compressor is cold. These motors are not of adjustable speed, so they should not be run on the induction windings more than 45 seconds. In other words, the cylinder must be practically free from pressure when the machine is started and the starting period should be as short as possible.

In a case of this kind my method of procedure is as follows:

Close the king valves on the receivers and start the water on the condensers. This will condense the gas in the condensers and will stop the flow of liquor (or gas if the seal is broken) from the receivers. See that all other valves and switches are in the proper positions for starting. Start the exciters and adjust their fields for the proper voltage. See that there is water on the cylinders and oil on the bearings. The oiler does the switching while I attend to the valves, as I have found that new men can comprehend the switching much easier than the proper adjustment of the valves. The suction, discharge and bypass valves being closed, I give the oiler the signal to close the low-voltage switches that start the motor induction, and at the same time I open the small bypass which leads from the discharge side of the machine to above the suction valve.

The warm gas is pumped out of the cylinder and at the same time the liquid which may have collected in the suction header vaporizes and enters the cylinder. By this time the oiler has the motor in synchronism and it is ready for the load. When the cylinder is free from gas, I close the small bypass and open the discharge valve immediately. I am now ready to open the suction valve. This should be done very carefully to prevent getting a slug of liquid in the cylinder. After pumping the back pressure down to normal I open the king valves and readjust the expansion valves, for by this time the receivers should contain considerable liquor.

In the plant here we have two 100-ton, double-acting, single-stage, horizontal compressors, driven at 150 r.p.m. by synchronous motors. We had just acquired a new man who was to be relief engineer, and I was given the job of breaking him in. He had been accustomed to steam-driven machines and evidently thought that these should be handled the same way.

During the winter we had not made much ice, so the principal load was maintaining the temperatures in the storages. Naturally, the back pressure was low and the suction gas wet, sometimes necessitating pinching the suction valve. Only one machine was needed to maintain these temperatures, so the suction header of the idle machine would be full of liquor. The weather being comparatively cold, we didn't bother to pump out this liquor when we shut down. It is easy to see that great care must be used if the machine which has been idle for some time is started.

One machine had been idle for about a month when I told the new man we would start it. I explained everything to him and cautioned him especially about opening the suction valve. I started the compressor with the bypass open and came over to the machine to adjust the valves myself. He was on the suction side of the machine when I proceeded to close the bypass and open the discharge valves. I had just begun to close the bypass when he got into a hurry and using a monkey wrench opened the suction valve about half way. The liquid from the header immediately dropped into the cylinder and the compressor began to pound. The dis-

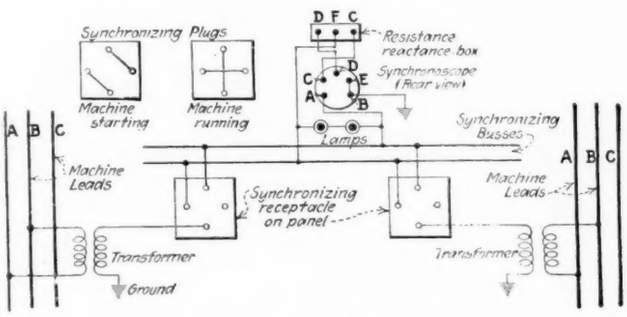
charge was still closed and the bypass partly open. My assistant fled for the door leaving the opening of the motor switch to me. By this time the liquor was running out of the piston-rod packing gland in a stream, the engine room was full of gas and the suction valve still open. Donning the gas mask, I closed the suction valve as soon as possible, but not before considerable ammonia had been lost. As soon as the engine room became habitable the other machine was started and the first one pumped out. It took about three hours to do the job. M. E. BELL.

Riverbank, Calif.

Phasing-out Alternating-Current Generators

In the issue of *Power* for Jan 8, 1924, there is an article on "Phasing-Out Generators for Parallel Connection," and Fig. 5 appears to me to be in error. The synchronoscope seems to be a G-E type, and if this is so then the connections are incorrect and the diagram shows them correct.

I may add that a simple method of checking these synchronoscope connections is to connect temporarily the synchronizing buses together, then insert one of



Synchronism-indicator connections

the plugs into one receptacle (either one). The pointer on the synchronoscope will immediately come on to the point of synchronism, if all connections are correct. Of course this will not show if the synchronoscope is connected correctly to corresponding phases of the different generators.

But if it is known that corresponding phases are connected correctly to the synchronizing receptacles, then the method mentioned can be relied upon to check the accuracy of the synchronoscope for synchronizing. ERNEST DICKINSON.

Kimberly, B. C., Canada.

"Recognition"

The "Foreword" in the Jan. 8 issue, recording the "swan song" of an unsuccessful superintendent, provides food for thought for all engaged in the field of power, whether employer or employed. The editor's survey of the situation explains much, but, as he admits, there is the other side at present unknown, but much can be surmised, and to dig into this may result in turning up something that may help some other brother who at the moment suffers from (or thinks he does) an exactly similar state of affairs.

The letter begins with the words "I have read *Power* for twenty-five years," a statement much open to doubt. He may have taken it in, or what is more probable, it may have been purchased for him by his firm, but had he read and understood the purpose of its publication he never would have penned his next sentence, "Now I am out of the power field completely and do not expect to be in it again." No man with the necessary grit and determination for a superintendent's position would make such a damning confession, but rather would he proclaim it far and wide that no firm would ever stop him or even delay him in his course. It also shows quite plainly that the necessary confidence in himself and courage to go forward are missing.

We are also informed that he has invented, designed and patented a good deal of useful machinery which has saved his firm many dollars. This may also explain much. During my active career I have met many inventors and have read hundreds of articles upon them, all of which point to the fact that the real out and out inventors who can do anything else, even to making their own inventions a commercial success, are few and far between. Our friend attempted both and failed, whereas had he stuck to one only he might have been successful.

We are also told that he continually asked for a raise in salary, which is another serious mistake. No doubt, he has been doing this for the whole fifteen years, and his employers probably got sick of his parrot-like action and preferred to have done with it even if it cost another thousand dollars. It has been my experience that the most successful superintendents and the highest paid never had to demand an increase of salary at any time, but have commanded it all the way up the ladder, and I am quite sure no man with an independent mind would have carried on inventing and supervising for fifteen years without tangible recognition.

Some twenty years ago I obtained a position with a firm that had an unfavorable reputation, and the fact that three men had failed to hold the position between them for a year was, I think, the main cause of giving it a trial as a new adventure. Everything went smoothly for about a fortnight, and then I found one of my workmen doing exactly opposite to what I had instructed him to do. On demanding explanations, I was informed that he had received contrary orders from the "old man." I suspended him immediately, and he did exactly as I expected, making straight for the old man's office with his tale of woe. Presently I was sent for, but before complying, I calmly washed my hands, put on my overcoat and locked up my office. Reaching his office, I threw the keys on his desk and calmly informed him that there wasn't any room for me about the place.

Of course the "old man" tried to explain and wanted to impress me that he owned the place. But to cut the story short, I stayed with him eight years and have never had a better or more considerate employer. My salary was advanced each year without any application on my part. When I left to take a more responsible position, it was his recommendation that helped most, and my assistant was in the first instance promoted temporarily to my position in case, as my old friend said, I wanted to come back. Which leads us to the conclusion that whether we are failures or not and whether our positions are good or bad depends more than anything else upon ourselves. F. P. TERRY.

Belfast, Ireland.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Evidence of Low Piston

How may it be known that an engine piston is low without taking off the cylinder head? **L. A.**

If the guides are parallel with the center line of the cylinder, and the piston rod packing is slackened with the gland resting on the rod when the piston is in the crank end of the cylinder, then if the piston is too low, the rod will press the gland upward in the stuffing box when the piston is in the head end of the cylinder.

Theoretical Power Obtainable from a Pound of Coal

Without any losses how many horsepower are there in a pound of coal containing 14,000 B.t.u.? **A. E. D.**

The term horsepower means development or transfer of energy at the rate of 33,000 ft.-lb. in one minute. Hence, to express energy in horsepower the rate of development or transfer of the energy must be taken into account. One B.t.u. is equivalent to 778 ft.-lb., and 14,000 B.t.u. contained in a pound of coal would be equivalent to a potential or stored up energy of 14,000 $\times$ 778 = 10,892,000 ft.-lb. If this much energy is developed or expended in one minute the development or expenditure is at the rate of 10,892,000 $\div$ 33,000 = 330 hp. If the energy is spread out over a period of 60 minutes, the average development per minute is $\frac{1}{60}$ of 10,892,000 = 181,533.3 ft.-lb. and the horsepower rate would be 181,533.3 $\div$ 33,000 = 5.5 horsepower.

Turbo-Alternating-Current Generators in Parallel

If two alternators are driven by turbines and operating in parallel and the emergency valve should shut off the steam on one of the machines, would this unit stop if the main switch were left in, or would the alternator take current from the other machine and run as a motor? **M. A. B.**

When two turbine-driven alternating-current generators are operating in parallel and the emergency valve closes on one of the turbines, the generators of this machine will continue to operate as a synchronous motor and take power from the other machines. Where the emergency valve is of the quick-opening type, it is best to close the throttle valve partly before opening the emergency valve, as this will prevent a heavy inrush of steam into the turbine. If the emergency valve is of a type that is open, the same as the throttle valve, then the throttle valve need not be closed before the emergency is opened, since you have control of the steam to the turbine through this valve. When the turbine is tripped off the line and the load thrown over to the other machine, the latter would be caused to slow down and with it the machine that had tripped off the steam line. This slowing down of the machine would cause the governor to open the valves to a greater degree than existed at the time the machine tripped off the line. Therefore, if a quick-acting emergency valve were to be opened without first closing the throttle valve, there would be a heavy rush of steam into the turbine before the governor could act and get the machine under control.

Size of Exciter for Alternator

What is the formula for calculating the required voltage and amperage for exciting alternators? **L. L.**

There is no formula for calculating the required voltage and amperage for exciting alternators. This is determined by the designers of the machine and varies with the type and make of alternator. The power required to excite the field of an alternating-current generator seldom exceeds 2 per cent and in large machines is less than 1 per cent of the capacity of the alternator. On modern alternators the excitation voltage and the capacity of the exciter are given on the name-plate. If not, the information is to be obtained of the manufacturer when informed of the name-plate data on the machine. If a source of direct current is available, the alternator may be started and brought up to normal speed and the field current increased through an adjustable resistance until normal voltage is obtained. Then, with a voltmeter, read the voltage across the terminals of the alternator field. This should be within a reasonable range of 110 or 220 volts. If only 110-volt current were available, and the alternator field coils were designed for 220 volts, it would be found impossible to get the alternator up to full voltage on 110-volt excitation and would show that the exciter voltage should be 220.

Theoretical Height of Raising Water with Steam Pump

What is the theoretically maximum height to which water can be raised by a direct-acting duplex steam pump, having 18-in diameter steam cylinders, 12-in. diameter plungers and 16-in. stroke, when supplied with steam at 120 lb. pressure? **O. E.**

Neglecting pipe and pump friction, the theoretical height would be that height or head that would exert the same pressure per square inch as the pressure per square inch that could be exerted by the pump plungers. With steam pistons each 18 in. in diameter and neglecting the reduction of piston areas by the piston rods, each steam piston would have an area of 18 $\times$ 18 $\times$ 0.7854 = 254.47 sq.in., and with the steam pressure 120 lb. per sq.in. gage, and back pressure equal to the

pressure of the atmosphere, the total force exerted by a steam piston would be 254.47 × 120 = 30,536.4 lb. As the cross-sectional area of each 12-in. diameter plunger would be 12 × 12 × 0.7854 = 113.1 sq.in., each plunger would be capable of exerting a pressure of 30,536.4 ÷ 113.1 = 270 lb. per sq.in. At ordinary temperatures of water each foot of head exerts a pressure 0.433 lb. per sq.in. Therefore the theoretical height to which water could be raised by the pump would be 270 ÷ 0.433 = 623 ft. above the level of the suction water.

Owing to the unavoidable mechanical friction, the plunger load is only a percentage of the steam force. A duplex pump with packed plungers has four large stuffing boxes for the plungers in addition to the piston and rod packings of the steam ends, and, all together, the packing may produce an enormous frictional resistance unless the adjustments are made with great care. Hence, in order to estimate the actual height that a pump may be able to lift the water, it is necessary to know the mechanical efficiency of the pump, the loss of pressure to be sustained in pipe friction, and the mean effective pressure of steam acting on the steam pistons, as well as the sizes of steam and water cylinders.

Setting the Valves of a Single-Valve Automatic Engine

What is the method of setting the valve of a single-valve automatic high-speed engine? *E. W.*

When the governor of the engine is fixed on the shaft or mounted on a keyed flywheel, the valve setting is as complete as it can be made when the lead is set for the head end. For most single-valve engines it is customary to set the valve so there will be greater lead on the crank end and thus more nearly equalize the cutoffs of opposite ends. However, equality of cutoffs is of less importance than sufficient lead. For setting the valve, block out the governor to average running position. Next adjust the length of valve rod to obtain equal cutoffs; then readjust the valve-rod length so there will be some lead at both ends of the valve. For most engines $\frac{1}{16}$-in. lead on the head end will be about right for average load, but whether this is the best amount should be determined, if possible, from indicator diagrams taken under regular working conditions.

Stuck Piston Ring of Oil Engine

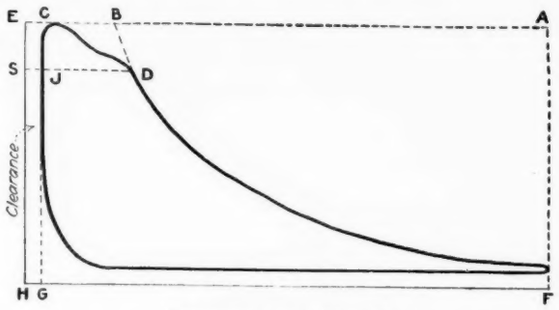
What is meant by a "stuck piston ring" when applied to an oil engine? What is the cause, and what harm is likely or possible to be caused by rings' sticking? *V. H.*

A "stuck piston ring" is one that is prevented from adapting itself to the diameter of the cylinder because the sides of the ring are held or stuck fast to the sides of adjacent rings or sides of the grooves or flanges of the piston between which the ring or rings are carried by the piston. Sticking may be due to initially fitting the rings too roughly or too tight on their sides; or from gumming of oil due to poor atomization of the fuel oil; or the use of too much lubricating oil. From any of these improper conditions, sticking of piston rings might occur in a few hours' run of the engine. The harm likely to be caused from sticking piston rings is leakage of the piston, fouling of the cylinder, increased frictional resistance to movement of the piston, and breakage of the rings, followed by damage from scoring of the cylinder.

Apparent and Actual Cutoffs

What is meant by actual and apparent cutoff? L. M. C.

Cutoff is closure of the admission valve of an engine. Referring to the indicator diagram shown, from the purely mechanical point of view the valve closes when the piston is at *D*, where the admission line sweeps into an actual expansion line. Then the ratio of apparent cutoff by the valve, commonly called "apparent cutoff," is *JD* ÷ *GF*. By extending the expansion line upward from *D* as a hyperbolic curve until it intersects *EA*, the line of admission pressure, gives the intersection *B*, and the ratio *CB* ÷ *GF* sometimes is called the commercial or equivalent cutoff. In order to have a true



Apparent cutoff at D

ratio of volumes present at the time of cutting off, we must include the clearance. In the figure the volume back of the piston at cutoff is represented by *SD*, while that at full stroke is represented by *HF*, and the real ratio of cutoff by the valve, simply called "real cutoff" or "actual cutoff" is *SD* ÷ *HF*.

Rattling of Corliss Valves

What causes rattling of the valves of a Corliss engine when lightly loaded? Also, when the engine has been run condensing and is changed to high pressure, what causes rattling of the steam valves? *H. N. T.*

In both cases the rattling is due to the valves' being forced from their seats by greater pressure than the pressure acting to hold the valves to their seats. This occurs to the exhaust valves of a non-condensing engine when it is so lightly loaded that, from shortness of the cutoff, expansion goes below the pressure of the atmosphere and, in a condensing engine running under a light vacuum, when expansion goes below the pressure in the condenser, the back pressure forces the exhaust valve off its seat.

When an engine is run condensing, to obtain sufficient compression the exhaust valves are set to close earlier than when operated non-condensing with the exhaust above the pressure of the atmosphere. Hence, with the exhaust valves set for operating the engine condensing, if it is operated non-condensing, the early compression may go higher than the pressure of steam admitted on top of the valve, and in this way a steam valve may become raised from its seat with a rattling noise when the piston is near the end of an exhaust stroke.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

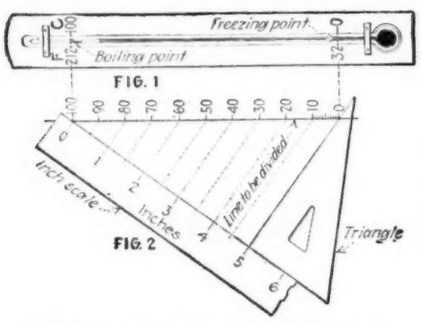
Sidelights on things generally used but less generally understood

Single-Line Diagrams

SINGLE-LINE diagrams are easy to make and often very convenient. The purpose and construction of such a diagram is best explained by a practical example. Suppose the scale of the thermometer shown in Fig. 1 is blank except that the freezing and boiling points are marked. It will not be difficult to lay out two scales, one for degrees Centigrade (C.) and the other for degrees Fahrenheit (F.). While degrees Fahrenheit are used almost exclusively in this country for engineering work, it is sometimes desirable to know the corresponding reading on the Centigrade scale, because that is the scale ordinarily used in purely scientific work in this country and for all purposes abroad, except in England, where the Fahrenheit scale is still considerably used.

If the bore of the thermometer is uniform, each of these scales will have divisions of uniform length. The only other information needed is that the Centigrade scale reads 0 at the freezing point and 100 at the boiling point, while the corresponding readings on the Fahrenheit scale are 32 and 212 respectively. These points have been so marked in Fig. 1.

It is now evident that to lay out a Centigrade scale it is only necessary to divide the space between the freezing and boiling points into one hundred equal parts. The first step is to divide



Figs. 1 and 2—Graduating a thermometer scale

Mark the freezing and boiling points 32 and 212 respectively for the Fahrenheit scale and 0 and 100 for the Centigrade scale. Use triangle and straight-edge as shown to subdivide the two scales.

the space into ten parts, each of which can later be subdivided into ten more.

Fig. 2 shows the method of dividing the large space into ten equal parts. The apparatus needed consists of a scale and a triangle. The first step is to find ten equal spaces on the scale that will add up to a distance somewhat less than the space to be divided. If an ordinary inch scale with half, quarter and eighth divisions is used, there is a considerable variety of spaces to select from, these being ½ in. ¼, ⅜, ½, ⅝, ¾, ⅞, 1, 1¼, etc. It so happens in this case that the total space to be divided is a little over 5 in., so that half-inch spaces on the rule will work in very well, since ten such spaces add up to 5 inches.

The scale is then placed as shown so that its zero is at the left end of the space to be divided and the perpendicular edge of the triangle extends from the 5-in. mark through the right end of the space. If now the scale is held tightly in place while the triangle is slid along to draw the dotted lines from the successive half-inch marks as shown, it is evident that the space will be divided into ten equal parts.

A similar method can be used for subdividing the space between 0 and 10

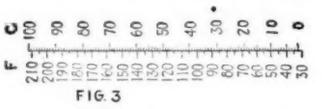


Fig. 3—Completed temperature scales

into ten equal parts. When one of these spaces has been thus subdivided, the divisions can be transferred to the edge of a piece of paper and easily copied in the other spaces.

To construct the Fahrenheit scale, the space between freezing and boiling can be divided into 180 equal parts by first dividing it into 18 parts and then sub-dividing each of these into 10 parts. It will be noted, however, that if the space from freezing to boiling were divided into 18 equal parts, the coresponding divisions would read 32, 42, 52, etc., which would be awkward. To avoid this difficulty the line may be drawn on another sheet, and the scale laid out, after which it can be matched up with the Centigrade scale by sliding it down until 212 comes opposite 100 on the Centigrade scale.

Now if the thermometer were imagined removed and the two scales simply laid off on oposite sides of a line, as shown in Fig. 3, we would have one good example of the single-line chart with which this article is concerned. Evidently, the value of such a chart would consist in the ability to read the Centigrade temperature corresponding to any Fahrenheit temperature, or vice versa. A single-line chart may then be defined as a line with one scale on one side and a scale of corresponding values on the other.

Such a diagram can be prepared for any equation of two variables, or, in plain English, for any case where one quantity depends upon the value of another and upon nothing else.

There are many cases where such a diagram can be applied. Take the matter of turning U. S. gallons into pounds of oil, where a light oil running 7⅛ lb. to the gallon is used. It is evident that the number of pounds depends only on the number of gallons, and nothing else. Therefore it should be

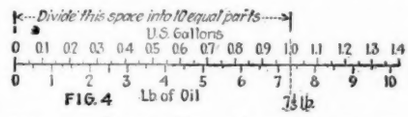


Fig. 4—Single-line diagram for converting U. S. gallons into pounds of (light) oil

A gallon of the given oil weighs 7⅛ lb. So lay off a uniform scale of pounds from 1 to 10. Then locate the zero of the gallons scale opposite the other zero and the 1-gal. mark opposite 7⅛ lb. Complete the diagram by dividing this space into ten equal parts and extending the divisions as far as necessary to the right.

possible to construct a single-line diagram with a scale for gallons on one side and pounds on the other, so that the weight can be read if the gallons were given, or the reverse.

Now it is desirable to have the scales on such a diagram as "open" as possible, to insure accuracy in reading. To get these large spaces, the total range of the scale should be made no larger than necessary. In this case the range may well be taken from 0 to 10 lb. of water. For rates above 10 lb. or below 1 lb. readings can be made on this scale by simply shifting the decimal point.

There are a number of different ways of constructing this diagram. That shown in Fig. 4 is perhaps the simplest. The first step is to lay off on the underside of the line the scale for weight of water running from 0 to 10. The spaces are chosen as large as possible within the limits of a convenient sized sheet. Now, two points on the gallon scale can be located at once. The first is 0 gal., which necessarily corresponds with 0 lb., and the second is 1 gal., which is known to correspond with 7⅛ lb. The space between 0 and 1 can thus be divided into ten equal parts by the method already shown. Additional divisions of the same length can then be added to the right of the 1-gal. mark to carry the scale as far as that for weight of oil. The main divisions on each side may be subdivided in any desired manner. Where both scales are subdivided on a decimal basis, this diagram can be used for any quantity of oil by merely shifting the decimal point. For example, to determine the number of gallons required to hold 475 lb., it is only necessary to note that 4.75 lb. equals 0.65 gal., so that 475 lb. must equal 65 gallons.

New and Improved Equipment

The Collins Micro-Indicator

A recently developed indicator for the production of diagrams from high-speed internal-combustion engines is shown in Figs. 1 to 3.

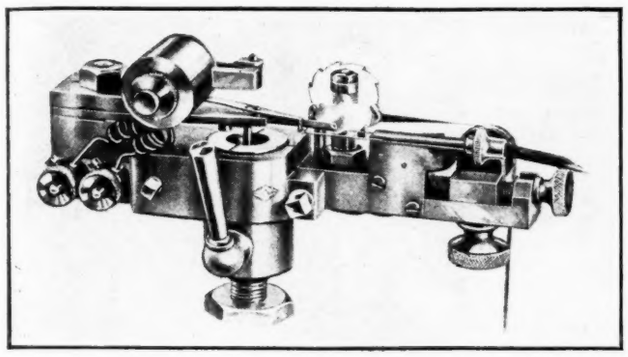
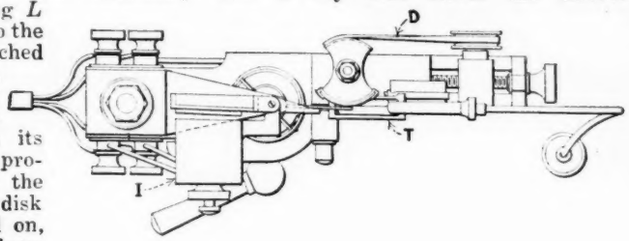


Fig. 1—Collins Micro-Indicator

The indicator is of the cylinder-and-piston type, having a removable cylinder liner of hard stainless steel, within which works the piston. This liner may be replaced by others of smaller area. The piston rod, which is formed solid with the piston, is kept in firm contact with the flat pressure spring *L* by means of the subsidiary spring *M*, the spring *L* being bolted firmly to the rigid frame. Attached to the pressure spring is a light arm *Q* carrying a recording stylus at its end. This stylus produces records near the edge of the celluloid disk *R*, which is carried on, and bent to conform with, the cylindrical surface of a vertical drum, to which it is secured by means of clips and a central pin. The drum is given a reciprocating motion about its axis from the light steel tape *D*, which after passing over an adjustable guide pulley, is attached to a crank or other suitable mechanism, synchronizing in movement with the engine piston and giving the periphery of the drum a travel of about 0.15 inch.



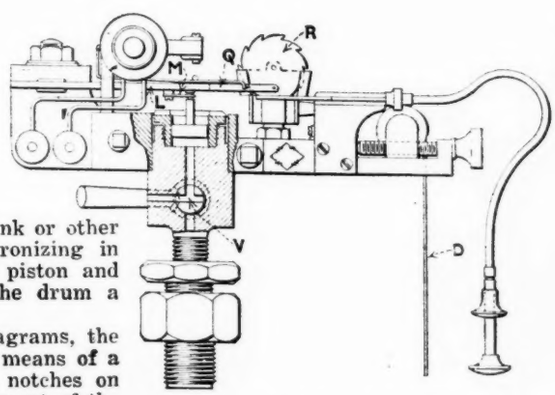


Fig. 2—Cross-section of indicator

To obtain a series of diagrams, the celluloid disk is rotated by means of a pawl *T* engaging with the notches on its circumference, the movement of the pawl being controlled by a Bowden-wire push-switch. This movement brings a fresh portion of the celluloid surface under the stylus, and by repeating the movement, several separate diagrams can be traced in rapid succession.

Normally the stylus is not in contact with the celluloid disk but it may be brought into contact by the electromagnet *I*. When this is energized, it attracts one end of a light pivoted arm, the other end of which bears against the arm *Q*, carrying the stylus, thus bringing the stylus against the face of the disk. This action puts the instrument in position to make a diagram.

The switch that controls the current to the core, carries a worm driven preferably at engine speed by gearing. When the wire push-switch is depressed to rotate the celluloid disk into position for a fresh record, it also closes the electric circuit through a magnet in the automatic switch. This magnet actuates a simple form of escapement which allows a spring-controlled pivoted arm to come into such a position that, when pressure on the knob of the wire is released and the magnet is demagnetized, a pin on the arm engages with the rotating worm, which draws the arm over. This action operates a key that closes the circuit through the electromagnet *I* on the indicator, bringing the stylus against the face of the celluloid disk. As soon as one engine cycle is completed, the arm is carried along by the worm to the position where the key reopens, thus breaking the circuit, and the stylus springs backward out of contact with the record disk. A light spring returns the arm to its original position.

The records made by the Collins micro-indicator are approximately 0.12 in. long and 0.1 in. high, and as they consist of indentations made by the stylus upon the celluloid surface, they are of a permanent character. The lines forming a diagram are clearly defined and will bear considerable magnification. The diagrams can be examined at once by means of a suitable microscope, or direct enlargements from the actual diagrams can be obtained by photographic methods. The instrument is sold in this country by the Cambridge & Paul Instrument Co., New York City.

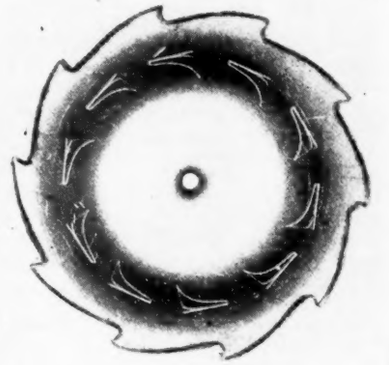
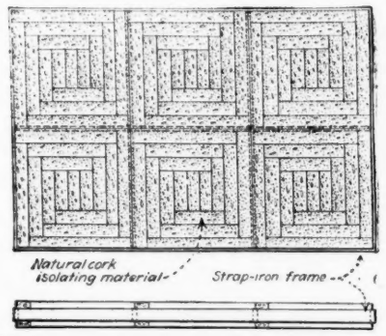


Fig. 3—Diagrams on the record disk

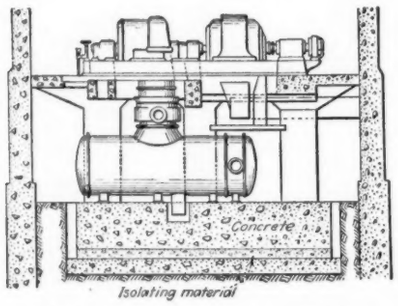
Korfund Plates for Isolating Machinery Foundations

A type of cork plates for use in foundations of all classes of machinery to isolate any vibrations that may be set up in the machine, from the surrounding structure or property, and a type that has been used extensively in many parts of the world, is now being introduced in this country by the Korfund Company, 42 Broadway, New York City.



Plates are constructed of cork strips held together by iron frame

These plates differ from other types of prepared cork materials used for this purpose, in that they are of natural grown cork. Referring to Fig. 1, the plates are constructed of strips or blocks of cork $1\frac{9}{16}$ in thick, arranged as shown. The strips are held tightly



Plates installed under turbine foundation

together by a wrought-iron frame, reinforced by internal longitudinal and lateral struts between the blocks, the iron frame being not quite so thick (vertically) as the cork squares. Securing the individual plates in this manner tends to insure permanency of the material.

The plates are adaptable for use under all classes of machinery and are made in size and shape to suit installation requirements. In Fig. 2 is shown a typical installation of these plates under a turbine foundation. The process of installing is quite simple and requires no skilled help. The plates are placed side by side on a flat surface of the sub-base and the foundation, which may be of concrete, timber or other suitable material, is built on top of it.

TEST RESULTS OF A KORFUND SLAB (8 IN. LONG, 8 IN. WIDE, $2\frac{1}{8}$ IN. THICK)

	Load in Pounds per Square Foot													
Test No.	5,100	10,200	15,200			20,300			25,400			30,400		
	a	a	a	b	c	a	b	c	a	b	c	a	b	c
1	....	8.5	25.5	7.5	5.0	38.2	15.7	8.8	44.0	19.3	11.7	45.5	21.7	13.3
2	4.5	7.8	23.5	8.8	4.3	38.5	14.0	8.5	43.3	18.7	10.8	44.5	18.7	12.5
3	1.7	6.8	26.3	7.3	3.0	39.7	12.3	5.8	44.7	14.3	7.7	48.7	18.0	8.5

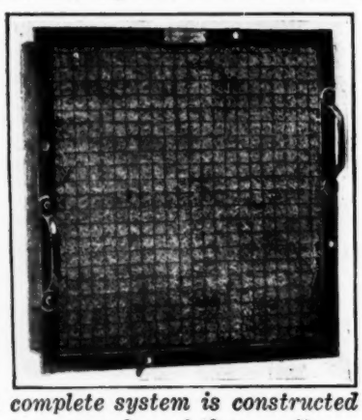
a. Permanent compression in per cent, under load. b. Compression in per cent immediately after load is removed. c. Compression in per cent five minutes after load is removed.

Reed Air Filter

A filtering system constructed of a number of units as shown in the illustration is a development of the William Reed Engineering Co., Louisville, Ky.

The filtering unit consists essentially of a steel frame containing a filtering medium of special-grade steel wire, which is subjected to a chemical coating process. In passing through the filter, the air changes in direction a number of times and is caused to impinge on the chemical-coated filtering material. To clean the filter, the units are removed individually from the channel iron frame and dipped into a cleaning tank, where they are first washed clean and then recharged with "Adhesine."

The units are made in sizes convenient for handling and for grouping together into a system to suit installation requirements.



A complete system is constructed of a number of these units

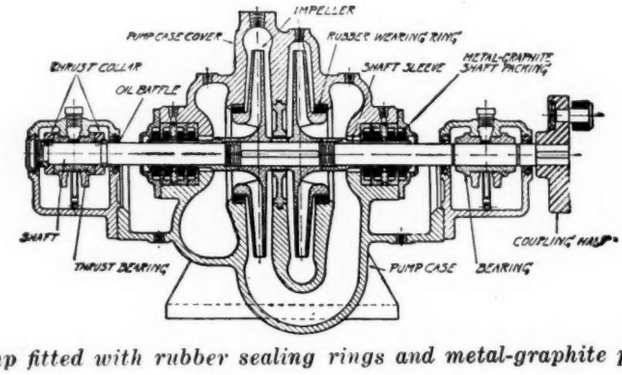
Moore Centrifugal Pump

The illustration shows a centrifugal pump recently developed by the Moore Steam Turbine Corp., of Wellsville, N. Y., which embodies certain special features. These include the use of rubber sealing rings on the impeller between the suction and discharge chamber and metal-graphite packing rings in the packing glands in place of the ordinary hydraulic packing.

The employment of rubber sealing rings tends to reduce the leakage of the pump at this point to a minimum and precludes the possibility of a frozen pump due to too close-fitting sealing rings if for any reason the pump should be operated for a short time without water.

The impeller shaft is protected by a brass sleeve where it passes through the stuffing box, and metal-graphite packing is used with a view to reducing the friction and wear on the shaft at this point.

The pumps are built in single and multi-stages and are arranged for motor, turbine and belt drive.



Pump fitted with rubber sealing rings and metal-graphite packing

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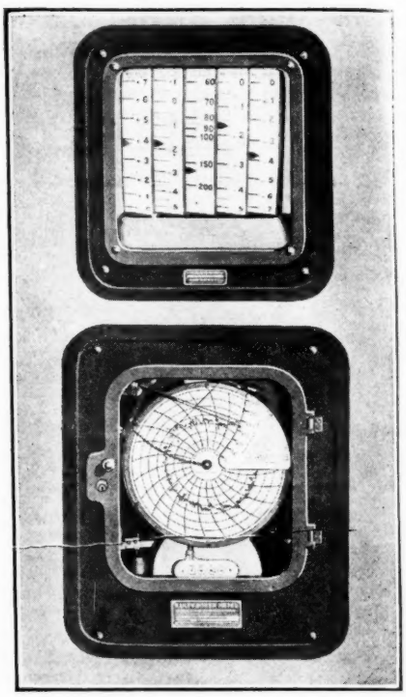
According to United States government reports, production of coal in Great Britain in 1923 was 278,500,600 tons, an increase of almost 28,900,000 tons over 1922 and with the exception of 1913 the largest annual output ever reached by the British coal mining industry.

New Bailey Flush-Front Type Boiler Meters

The Bailey Meter Co., Cleveland, Ohio, has recently added to its line of boiler instruments a new type of flush-front meters and gages, designed especially for panel board mounting. The instruments are so constructed that the meter casings and all connecting piping are behind the panels.



Flush-front meters mounted on panel

The meter in the lower part of the panel shown in the illustration is designed to record and integrate the steam flow and record the flow of air supplied to the furnace for combustion, while the multi-pointed gage in the upper part of the panel is arranged for indicating the steam pressure, stoker speed and draft at different points of a boiler or inlet and outlet of an economizer.

The panel shown illustrates one of the many combinations of these meters that can be made to meet practically any boiler installation requirement.

Economical Utilization of Heat from Central-Station Plants

The authors, N. W. Calvert and J. E. Seiter, who presented this paper at the annual meeting of the American Society of Heating and Ventilating Engineers, at New York, January, 1924, state that they have repeatedly witnessed reductions in heat consumption by improved operation of from 25 to 35 per cent, and in some cases 50 to 70 per cent.

THERE are two general methods for decreasing the losses in the utilization of heat. The first is the proper control of heat supply, and the second, the efficient use of heat. With central heat, however, complete utilization is essential for economy, as the consumer must pay for every B.t.u. that is put into the steam and consequently suffers considerable loss if 10 to 15 per cent of the total heat received is sent to the sewer with the condensate. Three methods of utilizing condensate heat are described.

The following fundamentals practically sum up the subject of economical utilization of central station heat:

1. Installation of sufficient and properly placed radiation.
2. Shutting off for maximum possible time at night and during the day.
3. Salvaging the heat in the condensate.
4. Proper temperature control.
5. Reduction of transmission loss.

If the foregoing factors are given proper consideration in the design and operation of the heating system, maximum comfort at a minimum cost is practically assured.

Central-station heating offers an unlimited source of supply and a marked flexibility of operation. It also presents a much greater possibility of waste than that of an isolated boiler plant, as in the latter the supply of heat is

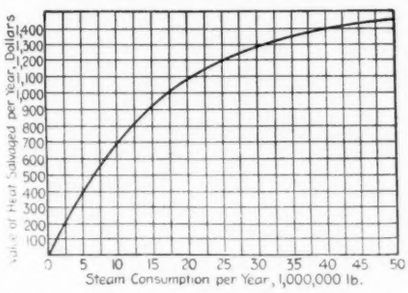


Fig. 1—Heat salvaged by same size economizer in buildings with different steam consumption

ordinarily regulated by the rate of boiler firing, representing a comparatively positive control of the heating in general. In the case of central heating steam, regulation ordinarily depends on the control exerted by the consumer. This may be allowed to run at full supply during the night when no heat is needed, producing a considerable waste. In an isolated plant also, the condensate ordinarily returns to the boiler at a high temperature, representing greater economy than where condensate is allowed to go to the sewer with a consequent loss of 10 to 15 per cent.

The required heat may be reduced by shutting off the steam entirely during the night, when the majority of the buildings are unoccupied. The rate of heat transmission from a building depends on the differential of temperature between the interior and the exterior. A saving may be effected in daily steam consumption by shutting off the heat during the night hours, guided by a knowledge of the rate of cooling. With an outside temperature of 31 to 32 deg. F. for an office building of 5,865 sq.ft. radiation, the daily steam consumption was reduced from 29,170 lb. to 15,000 lb. by this method.

The vacuum systems and thermostatic control systems are discussed. In the latter an intermediate type thermostat is to be preferred which will open the radiator valve only a small part at a time in accordance with required load rather than the wide open type which either opens the valve entirely open or closes it fully. By the use of vacuum systems it is possible to vary the temperature of the steam in the radiators considerably, by adjusting the vacuum and thereby varying heat transfer. Results are shown where proper application of thermostat valves reduces steam consumption approximately 50 per cent in a 1,220-sq.ft. apartment building. A table of results obtained by the installation of a vacuum system in a 6,400 sq.ft. equivalent radiation system is given in Table I.

TABLE I—VACUUM SYSTEM REDUCES HEATING REQUIRED

Total consumption, Oct. 1, 1921, to May 1, 1922 (before installation)	3,642,505 lb
Total consumption, Oct. 1, 1922, to May 1, 1923 (after installation), corrected to temperatures for 1921-22	3,297,500 lb.
Saving in 7 months operation with vacuum	345,000 lb.
Average saving per month	50,000 lb.
Estimated total saving for season, 8 months	395,000 lb.
Estimated saving in dollars, with steam at $1 per 1,000 lb	$395 00
Total actual cost of pump and piping installed	$658 00

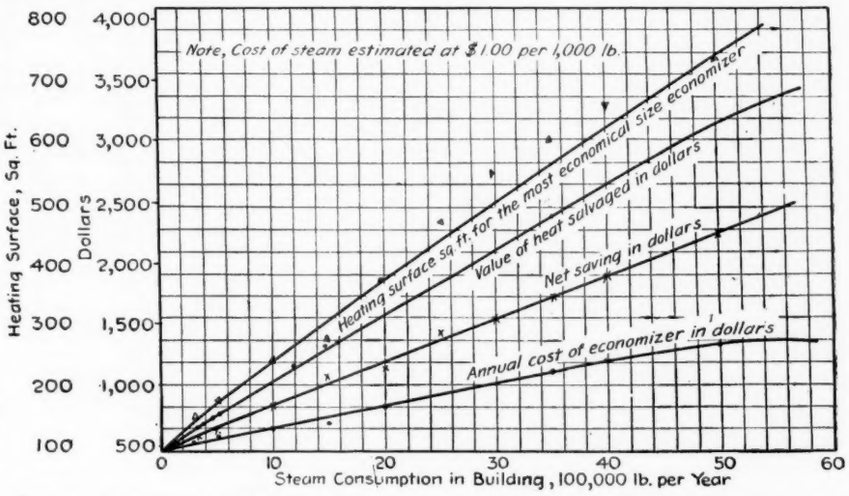

Heating Surface, Sq. Ft.
Dollars
800 4,000
700 3,500
600 3,000
500 2,500
400 2,000
300 1,500
200 1,000
100 500
Note, Cost of steam estimated at $1.00 per 1,000 lb.
Heating surface sq. ft. for the most economical size economizer
Value of heat salvaged in dollars
Net saving in dollars
Annual cost of economizer in dollars
0 10 20 30 40 50 60
Steam Consumption in Building, 100,000 lb. per Year

Fig. 2—Values of heat saved by applying economizers of size used in Fig. 1

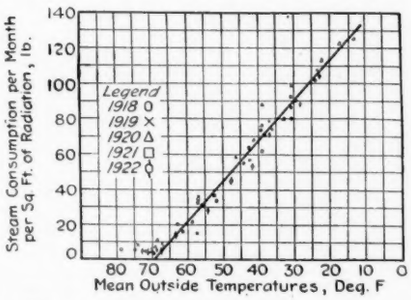


Fig. 3—Sales of steam per sq.ft. of radiation

One of the most important features of this paper is the discussion of the application of economizers for utilizing the heat otherwise wasted in the condensate. The heat of the rejected liquid constitutes about 15 per cent of the total used for heating buildings. This may be utilized by the indirect air heating economizer in which air is heated by means of a coil enclosed in a sheet-metal box and used for supplying a register in the floor. The direct air heating economizer is limited to heating systems having sufficient pressure in the return lines to raise the condensate to the economizer. Here the condensate is used in water coils as in the usual water heating system. The water heating economizer utilizes this heat for the supply of hot water required for many buildings.

Figs. 1, 2 and 3 indicate practical results in the application of economizers. Fig. 3 is a general average of steam sold per square foot of radiation, for all types and sizes of buildings. Factors were computed from a study of 173 Detroit buildings each having over 4,000 sq.ft. of radiation.

Tentative Program of American Committee World Power Conference

American Power Developments from Construction and Operation Standpoints Is Theme of Program

THE tentative program of the American Committee of the World Power Conference to be held in connection with the British Empire Exposition, June 30 to July 12, at Wembley, London, has just been announced. O. C. Merrill is general chairman of the American Committee. John W. Lieb is chairman of the Program Committee, of which Peter Junkersfeld and Calvert Townley are the other members.

The program as presented is tentative, the formal titles of the papers and other arrangements not having been decided upon fully. The plan of the Program Committee was to explain the character and extent of American power development from both construction and operation standpoints, and give opportunity for setting forth conditions under which American capital has been able to undertake this development.

Review of Power Resources

The first division of the program will give a "National Review of Power Resources, Their Distribution and Utilization," by O. C. Merrill, executive secretary, Federal Power Commission, N. C. Grover, chief hydraulic engineer, U. S. Geological Survey, and M. R. Campbell, geologist, U. S. Geological Survey. Regional reviews will be given as follows: For the Northeastern States by John W. Lieb, vice-president New York Edison Co.; for the Central States by Samuel Insull, president Commonwealth Edison Co. of Chicago, and for the Pacific States by A. H. Markwart, vice-president Pacific Gas & Electric Co., and H. A. Barre, executive engineer, Southern California Edison Co.

Water Power and Fuels

The "Problem of Water-Power Production" will make up the second section of the program. John R. Freeman, consulting engineer, Providence, R. I., will give a general review of Current Practice. Henry J. Pierce, president of the Washington Irrigation and Development Co., and E.C. Bebb, hydraulic engineer, Federal Power Commission, will outline the "Relation Between Power Developing and Irrigation." A. P. Davis, consulting engineer, will discuss the "Design and Construction of High Dams." Two authors will treat problems of waterwheels, the paper on "Impulse Waterwheels" being given by William M. White, manager and chief engineer, Allis-Chalmers Manufacturing Co., and the paper on "Reaction Wheels," by H. Birchard Taylor, vice-president of William Cramp & Sons, Ship & Engine Building Co. "Power Development on Navigable Rivers" will be treated by an author to be announced later.

The section of the program devoted to the "Preparation and Use of Fuels" will consist of one paper by C. F. Hirshfeld, chief of the research department of the Detroit Edison Co.

Steam and Electric Power

The discussion of "Steam Power Production" will be opened by a "General Review of Current Practice" prepared by Peter Junkersfeld and George A. Orrok, consulting engineers. D. S. Jacobus, advisory engineer of Babcock & Wilcox Co., will review "Present Practice of Steam Generation in the United States," W. L. R. Emmet, consulting engineer General Electric Co., will write on "Power from Mercury Vapor," and W. S. Monroe, of Sargent & Lundy, will present the "Latest Development in High Pressure and Superheat." "Steam Turbines and Condensing Equipment" will be handled by Francis N. Hodgkinson, chief engineer of Westinghouse Electric & Manufacturing Co., South Philadelphia Works.

"The Electrical Problems of Transmission and Distribution" will be presented by three authors: B. G. Lamme, chief engineer, Westinghouse Electric & Manufacturing Co., who will treat the topic of "Electrical Equipment for Power Stations," F. G. Baum, consulting engineer, who will discuss the "Technical Problems of High Tension Electric Transmission," and W. S. Murray, consulting engineer, who will relate the "Economies of Power Development in Large Stations Interconnected Into a Single Superpower System."

Industrial Phases

The "Industrial Phases of Power Utilization," will be represented by three papers: One on "Steel Mill Operation," by B. H. Shover, consulting engineer; one on the "Textile Industry," by Charles T. Main, consulting engineer; and the third on the "Paper Industry," by A. H. White, chief engineer, International Paper Co.

A general review of "Electrochemical Progress and Processes in the United States," will be given by F. A. J. FitzGerald, of the FitzGerald Laboratories of Chicago. "Electric Power in Metallurgy," will be discussed by an author to be announced later.

The discussion of the "Power Problems of Transport," will be provided in two papers, one on "Railroad Electrification," by Bion J. Arnold, consulting engineer of Chicago and the second on "Electric Ship Propulsion" by an author to be announced.

Economic Phases

Under the section devoted to the "Economic, Financial, and Legal Phases of Power Development," Herbert Hoover, Secretary of Commerce, will present the "Government Policies Relating to Power Development," S. Z. Mitchell, president of the Electric Bond & Share Co. will outline the "Problems of Financing Power Development" in the United States," Guy E. Tripp, chairman of the Board of the Westinghouse Electric & Manufacturing Co. will give the "Relation of Power Development to Industrial and Economic Progress." Owen D. Young, chairman of the board, General Electric Co., will present the "International Viewpoint on Power Development," and Carl D. Jackson, former president of the National Association of Railway and Utilities Commissioners, will relate the "Policy and Practice in the United States in Public Regulation of Public Utilities." An author to be announced later will discuss "Private Versus Public Ownership and Operation."

"The Relation of Power Application to Public Welfare and Industrial Expansion" is the general intent of the subject of a paper by Julius Barnes, president of the United States Chamber of Commerce, which will be given in the general section of the program. This section will also contain papers by E. W. Rice, Jr., honorary chairman of the board of the General Electric Co., who will point out "New Fields for the Application of Power," and Arthur E. Kennelly, professor of electrical engineering at Harvard University and Massachusetts Institute of Technology, will tell of "Progress in International Standardization in the Power Field." The fourth paper in this section will treat of the "Relation of Power Development to Labor," by an author to be announced at a later date. F. H. Shepherd, W. B. Potter and L. B. Stillwell will participate by discussion of "Railroad Electrification," and H. I. Harriman will discuss the "Relations of Power Development to Industrial and Economic Progress."

Pratt Institute, Brooklyn, New York, announces that the public exhibition of its schools of science and technology will be held on the evening of Mar. 13. This evening school provides technical instruction of practical value to men employed in industry and engineering.

Engineers Insist on Reorganization of Department of the Interior

James Hartness, President of the American Engineering Council Tells of Importance

FORMER Governor James Hartness, of Vermont, and the president of the American Engineering Council, said in a speech given before the American Society of Mining and Metallurgical Engineers at their recent convention held in New York City, that the Council had plans to force a reorganization of the Interior Department as regards natural resources.

The plan is sponsored by Secretary of Commerce Herbert Hoover, Calvert Townley, Col. Arthur S. Dwight, J. Parke Channing, Gardner S. Williams and other leaders in the engineering profession.

"The Engineering Council," said Governor Hartness, "is about to set in motion a nation-wide movement to bring about government reorganization. There are indications that the Brown Plan, the scheme sanctioned by Mr. Harding, is likely to fail, and the engineers regard it as their duty to call this situation to the attention of the American public. What the engineers want particularly is the making over of the Department of the Interior so as to bring about an intelligent co-ordination of the immense public works function of the government.

"Much of the progress toward governmental reform in this country has resulted from the effort of the engineer, and it is confidently believed that the movement to reorganize the Department of the Interior will add another and inspiring chapter to the development of the democratic tradition in organized engineering."

Carolinas to Have Two New Power Plants

Two new electric power plants will be built in the Carolinas by the J. B. Duke interests, according to press reports. One will be a steam plant at Duncan, S. C., near Spartanburg, and the other will be a hydro-electric plant at Hickory, N. C. Each will have an output of approximately 40,000 hp.

Export of Coal to France Greatest During 1923

The coal exported overseas by the United States during 1923 amounted to 4,064,496 tons, while the coke exports were 436,685 tons. France headed the list of countries, purchasing 842,669 tons of coal and 128,418 of coke; Cuba came second with 610,619 tons of coal and 6,315 of coke; Italy was third, purchasing 585,085 tons of coal and 24,880 of coke. The Netherlands and Germany were also good purchasers.

Tennessee Electric Power Co. Wins Suit

The Tennessee Electric Power Co. has won its suit instituted by the State of Tennessee, alleging violation of the Anti-trust act because of the company's control of the electric power business in the territory served by it and subsidiary companies. The ruling may prove of far-reaching consequence to other utility companies in establishing a precedent by which electricity cannot be defined as an "article of domestic growth or domestic raw materials" and that provisions of the act relating to such items therefore do not apply. It was also held that electricity was not an article manufactured from domestic raw materials.

The power company, it is reported, is extending its construction program inaugurated during 1923 to this year. A steam-power station that will have a generating capacity of 53,000 hp. is being constructed at Hales Bar, and it is anticipated that the first unit of 26,500 hp. will be in service before July 1, 1924. Additions to the Great Falls water-power plant also are being constructed and, when completed, will add 28,000 hp.

Pineville Plant To Start Operation Soon

The Kentucky Utilities Co. is soon to start operating its new Pineville plant, the first generating unit of which was shipped recently to them by the General Electric Co. This unit was a 15,000-kw., 0.8 power factor or 18,750-kva., 60-cycle, 1,800-r.p.m., turbine-generator. It is designed to operate at 300 lb. gage pressure and 210 deg. F. superheat. A 200-kw. direct-connected exciter and switchboard for controlling the unit was also furnished. The second unit will be shipped the latter part of this year.

The Pineville plant will furnish power for distribution in the vicinity for general purposes. It is expected that the ultimate capacity will be about 200,000 kilowatts.

Bituminous Miners' Wage Scale Approved

A renewal of the present bituminous miners' wage scale for a term of three years was approved unanimously by the subcommittee of miners and operators of the central competitive field, which met at Jacksonville, Fla., on Feb. 18. The agreement was counted as a victory for the miners and their international president, John L. Lewis. The contract is expected to become effective on April 1, after it has been subjected to a referendum vote of the members of the United Mine Workers of America, both bituminous and anthracite. Nothing will be changed by the renewal. Wages, conditions and all else except the term of years remain as they have been since the strike of 1919. The operators are well content by the arrangement and believe that the next contract will be signed for six years.

Deerfield River Dam Completed

The Davis Bridge Dam of the New England Power Co. is completed. From now on it can hold back the floods of the upper Deerfield River in southern Vermont, and when in a few weeks the spring rains come and the snows melt over the 200 square miles of territory which this section of the river drains, then the reservoirs will become a lake extending 10 miles up the valley, among the Green Mountains. What used to be 800 acres of woodland and 1,400 acres of pasture and meadow will be covered by 38 billion gallons of water, conserved to supply, especially in time of summer drought, hydro-electric power to drive the industries of New England.

The final step in the completion of the 200 ft. high dam, highest earth dam in the world, was to plug the diversion tunnel, which has taken care of the river flow in times of flood as well as under normal conditions, while construction was going on from June 1, 1922, to the present time.

The tunnel, 22 ft. in diameter, was drilled through the solid rock of the hillside, to form a giant bypass 1,500 ft. long. That section between the downstream outlet below the dam and the spillway, located within the reservoir 300 ft. upstream from the center line of the dam, was designed to be the permanent spillway tunnel which will take care of the discharge of surplus water when the reservoir is full and running over.

Houston New Power Station Progressing

The first unit for the Houston Lighting & Power Company's new station at Houston, Tex., was shipped recently by the General Electric Co. The ultimate capacity of this station is 180,000-kw. Units for furnishing a total of 40,000 kw. are now on order, the first having been shipped and the second to follow shortly.

Each unit is rated at 20,000 kw., 60-cycle, 0.8 power factor. The turbines will operate on a pressure of 300 lb. and 200 deg. F. superheat and will be equipped with direct-connected exciter. Other equipment will include steam and feed-water flow meters and motors for auxiliaries. The power from the turbines will be delivered to two 20,000-kva. transformers for distribution purposes. This new station was designed to supply power to the City of Houston in connection with the existing Gable St. plant and will be used for street railway, lighting and industrial purposes.

The number of mechanical stokers sold during December, 1923, as reported by the Department of Commerce is 73. They were installed under 17 fire-tube boilers of 28,200 sq.ft. of heating surface and 56 water-tube boilers with 296,970 sq.ft. The record of stokers sold for the other months of 1923 can be found in the Jan. 1, 1924, issue of *Power*. The total number of stokers sold for 1923 was 1,464 installed under 177 fire-tube boilers of 258,320 sq.ft. of heating surface and 1,287 water-tube boilers of 7,046,140 sq.ft.

Society Affairs

The Connecticut Branch of the N.A.S.E. will hold its regular meeting at Bridgeport, Conn., on Mar. 5.

The Baltimore Section of the A.S.M.E. will be addressed by Fred R. Low, president of the society, at its Mar. 6 meeting.

The Metropolitan Section of the A.S.M.E. will have "Elevators" as the subject of its March 5 meeting, which will be held in Brooklyn.

The Chicago Section of the A.I.E.E. will, at its Mar. 10 meeting, hear about "The Economics of Engineering." Prof. Riggs, of the University of Michigan, will be the speaker.

The Virginia Section of the A.S.M.E. has as the topic of its Mar. 14-15 meeting, which is to be held at Lynchburg, Va., "Mechanical Equipment of Industrial Buildings." William M. Thornton will be chairman of the meeting.

The Engineers' Society of Milwaukee will have as the subject of its Feb. 27 meeting "The Relation of the Engineering College to State Industries." Dean F. E. Turneaure, of the Engineering College of the University of Wisconsin, will be the speaker.

The Birmingham Section of the A.S.M.E. will meet at the Hillman hotel on Mar. 19. The general topic of the meeting will be "Power." W. E. Mitchell will speak on the "Development of Alabama Resources Electrically," and Martin J. Lide on "Powdered Coal and Waste-Heat Dryers."

The A.S.M.E. in connection with its Spring meeting to be held in Cleveland in May, will hold a joint meeting with the **American Society for Testing Materials**, at a morning session on May 28, to discuss "Effect of Temperature upon the Properties of Metals." The following papers have been approved by the committee: "Industrial Application of Metals at Various Temperatures," by L. W. Spring; "Methods of Testing and Their Limitations," by V. T. Malcolm; "Available Data on the Properties of Iron and Steels at Various Temperatures," (with bibliography), by H. J. French; "Available Data on the Properties of Non-Ferrous Metals at Various Temperatures" (with bibliography), by A. E. White and Clair Upthegrove. One of the purposes of the discussion is to secure information that will result in fixing practical performance ratings for materials used at high and low temperatures.

Personal Mention

W. H. Driscoll has been appointed chairman of the Committee on Research of the American Society of Heating and Ventilating Engineers.

B. Morris Hooper, formerly with the engineering organization of H. M. Havens, A. T. Hopkins, Inc., Boston, Mass., in appraisal work and industrial plant design and construction has joined the division of construction and engineering of Stone & Webster, Inc., Boston, Mass.

Coming Conventions

American Electrochemical Society. C. G. Fink, Columbia University, New York City. Meeting at Hotel-Bellevue-Stratford, Philadelphia, Pa., April 24-26.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Spring convention at Birmingham, Ala., April 7-10.

American Society of Civil Engineers. John H. Dunlap, 29 West 39th St., New York City. Spring meeting at Atlanta, Ga., April 9-12.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29, formerly announced, May 19-22.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

Association of Iron and Steel Electrical Engineers. W. M. Chandler, 708 Empire Building, Pittsburgh, Pa. Fuel Saving Conference—Combustion Engineers. April 2-3.

Electric Power Club. S. N. Clarkson, Keith Bldg., Cleveland, Ohio. Meeting at Seaview Golf Club, Absecon, N. J., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Kansas Association** at Parsons, Kans., April 16-18. J. M. VanSant, 739 Horne St., Topeka, Kan. **Indiana Association** at La Fayette, Ind., May 5-6. Prof. A. W. Cole, Purdue University, Lafayette, Ind. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at Bridgeport, Conn., June 27-28. George F. Klopfer, 30 East Pearl St., New Haven, Conn. **New England States Association** at Cambridge, Mass., July 10-12. Freeman L. Tyler, 32 Briggs St., Taunton, Mass. **Minnesota Association** at Fairbault, Minn., July 31, Aug. 1-2. C. A. Nelson, 800 22 Ave., N. E. Minneapolis. **Michigan Association** at Grand Rapids, Sept. 8. Wm. H. Yeomans, 209 Plainfield Ave., Grand Rapids.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 11-14, 1924.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24. **Nebraska Section,** H. M. Davis, Banker's Life Bldg., Lincoln, Neb. Sectional meeting at Omaha, May 8-9. **Southwestern Division,** S. J. Ballinger, San Antonio Public Service Co., San Antonio, Texas. Divisional meeting at New Orleans, April 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

James H. McGraw, president of the McGraw-Hill Co., Inc., sailed for Europe on the "Berengaria," Feb. 16, for a visit of several months' duration.

Alvin C. Purdy has resigned from the staff of the department of chemistry of Cornell University to take charge of the chemical division of the Streamline Filter Corp., New York City.

Edward B. Elliott, formerly power engineer for the Solway Process Co., Syracuse, N. Y., has been appointed engineer in the mechanical division of Stone & Webster, Inc., Boston, Mass.

C. H. Berry has been appointed technical engineer of power plants of the Detroit Edison Co. Mr. Berry succeeds P. W. Thompson, who has been appointed chief assistant engineer of power plants.

Eugene L. Fallon, formerly assistant electrical engineer for the Aluminum Company of America, Niagara Falls, N. Y., has joined the electrical division of Stone & Webster, Inc., Boston, Mass.

William de la Barre, who has retired as engineer in charge of the water-power companies at Minneapolis, was the guest of honor at a dinner given at the Minneapolis Club recently. Mr. de la Barre is now retiring after 45 years of active service with the milling industries of Minneapolis.

Business Notes

Lockwood, Greene & Co., Inc., Boston, Mass., announce the removal of their New York office from 101 Park Ave. to the Pershing Square Bldg., 100 East 42nd St., New York City.

The Carborundum Co., Niagara Falls, N. Y., has announced plans for a new administration and office building which with equipment will cost $300,000. It is to be located on Buffalo Ave., near the Niagara Falls Power Co. Work will be started at once and the building is expected to be ready for occupancy about Nov. 10.

Charles Cory & Son, 183 Varick St., New York City, announce that George M. Marr, formerly district manager in their Philadelphia office, has been transferred to the sales department in the New York office. Robert L. Reaves, formerly electrical engineer at Hog Island, has been appointed to the district managership in Philadelphia to succeed Mr. Marr.

Trade Catalogs

Insulation, Heat.—The Philip Carey Co., Cincinnati, Ohio. Bulletin No. 102 "Heat Losses from Bare Iron Surfaces," gives tables of losses from horizontal bare iron steam pipes and a curve showing heat losses from horizontal unpainted white canvas surfaces.

Transmission, Speed Reducing—D. O. James Manufacturing Co., Chicago, Ill. Bulletin No. 8 shows the various kinds of speed-reducing transmissions made by the company and their adaptation in numerous industries. Tables giving complete physical data are of special value.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Feb. 11, 1924	Feb. 18, 1924
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.25	2.25
Clearfield	Boston	2.40	2.25
Somerset	Boston	2.50	2.50
Kanawha	Columbus	1.75	1.75
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	1.85	1.85
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.75	2.75
West Ky.	Louisville	1.90	1.90
S. E. Ky.	Louisville	2.00	2.00
Big Seam	Birmingham	1.85	1.85

FUEL OIL

New York—Feb. 20, light oil, tank-car lots, 28@34 deg. Baumé, 5c. per gal., 36@40 deg. 5½c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Feb. 12, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.95@$2 per bbl.; 26@28 deg., $2@$2.05; 28@30 deg., $2.10; 32@36 deg., gas oil, 5¼@5¾c. per gal.; 36@40 deg., distillate, 6¼@6½c. per gal.

Pittsburgh—Feb. 14, f.o.b. local refinery, 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 6c.; 34 deg., neutral 9¾c. per gal.

Cincinnati—Feb. 11, tank-car lots, f.o.b. local refinery, 26@30 deg. Baumé, 6c. per gal.; 30@32 deg., 6½c.; 38@42 deg., distillate, 7½c. per gal.

Dallas—Feb. 15, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Philadelphia—Feb. 15, 28@30 deg., $2.31@$2.36 per bbl.; 18@22 deg., $2.10@$2.16½; 13@16 deg., $1.45@$1.51½ per bbl.

Boston—Feb. 11, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baume, 4½c. per gal., light oil, 28@32 deg. Baumé, 6½c. per gal.

Chicago—Feb. 18, 24@26 deg., $2.12 per bbl.; gas oil, 32@36 deg., 4.93c. per gal.

New Plant Construction

Ala., Bessemer—The Alabama Water Co. is considering the installation of electric-operated pumping machinery in connection with proposed extensions and improvements in plants and system to cost approximately $200,000.

Ala., Florence—The United States Engineer Office will take bids until Mar. 22, for four electric generators, each 32,500 kva. capacity, with exciters and accessories, as per specifications on file.

Ariz., Phoenix—The Crystal Ice & Cold Storage Co. is planning for the immediate construction of a four-story and basement cold storage plant, 40 x 54 ft., on local site. Lescher & Mahoney, Bank of Arizona Building, are architects.

Ark., Hot Springs—The Hot Springs Ice & Cold Storage Co., recently formed, has plans for the erection of a one-story ice-manufacturing plant, to be equipped for an initial capacity of 30 tons per day. Samuel G. Smith is president.

Ark., Little Rock—The Arkansas Brick & Tile Co. is planning for the rebuilding of the portion of its plant, recently destroyed by fire, to include the construction of a steam-operated power plant, with boilers, reciprocating engine and auxiliary equipment.

Australia, Melbourne—The chief storekeeper, Victorian Railways Commission, will take bids until Mar. 19, for one two-stage, intercooled-type air compressor, with capacity of 2300 cu.ft. free air per minute. Specifications at the offices of the Bureau of Foreign and Domestic Commerce, 734 Customhouse, New York; Witherspoon Building, Philadelphia, Pa.; and 76 West Monroe Street, Chicago, Ill.

Calif., Calexico—The Common Council is planning for the installation of electric-operated pumping machinery in connection with proposed waterworks extension to cost $40,000, for which bonds will be issued.

Calif., Oakland—The H. J. Heinz Co., 1062 Progress Street, Pittsburgh, Pa., manufacturer of canned foods, plans for the construction of a power house at its proposed local branch plant at Bay and Cedar Streets, estimated to cost $1,000,000.

Calif., Redwood City—The Pacific Portland Cement Co., Pacific Building, San Francisco, plans for the construction of a power house at its new local cement mill on which work will soon be commenced, estimated to cost $1,000,000. W. C. Stevenson, Pacific Building, San Francisco, is engineer.

Calif., Stockton—The Board of Public Works plans for the construction of an electric pumping plant in connection with the proposed project for water supply from the Calaveras River, estimated to cost $1,700,000. Application has been made to the state for permission.

Calif., Whittier—The Board of Education is having plans prepared for an individual boiler plant in connection with a number of school buildings for the local elementary school, to cost $235,000. Harvey H. Lockridge, 700 Markwell Building, Long Beach, Calif., is engineer.

Del., Dover—The Board of Directors, Murphy Home, will take bids at once for the construction of a steam power house at the institution, in connection with new dormitory buildings, for which plans have been drawn by Frank R. Watson, 1211 Walnut Street, Philadelphia, Pa., architect. Harry Mayer, Kings Highway, Dover, is secretary of the board.

D. C., Bolling Field—The United States Army Department, Washington, D. C., has authorized the construction of a pumping plant for a proposed local sewerage system, for which bids will soon be asked by the constructing quartermaster.

D. C., Washington—The United States Army Department has authorized the installation of two boilers and auxiliary equipment at the Washington Barracks, for which bids will soon be asked by the constructing quartermaster.

D. C., Washington—The United States Engineer Office, 250 Old Land Office Building, will receive bids until Feb. 29, for 63 sluice gates, as specified in Circular 24-213.

Fla., Caryville—The Henderson-Waits Lumber Co. has preliminary plans for the installation of a heavy duty Corliss engine in its power house, and auxiliary equipment.

Fla., Cocoanut Grove—The Common Council plans for the installation of electric-operated pumping machinery in connection with a proposed waterworks to cost about $200,000.

Fla., Pahokee—The Pahokee Utilities Co., recently organized, has tentative plans for the construction of a new power plant and ice-manufacturing plant for service at East Beach, and vicinity. J. H. Cason is secretary and treasurer.

Ga., Fort Bennington—The United States Army Department, Washington, D. C., has authorized alterations and improvements in the local refrigerating plant, for which bids will soon be asked by the constructing quartermaster.

Ga., Macon—The Central of Georgia Public Service Co., recently organized as an interest of the Central Georgia Power Co., has acquired a tract of 22 acres of land near the city, as a site for a new steam-operated electric generating plant, with initial unit of 13,000 hp. capacity. The complete station will consist of five units, and is estimated to cost $2,000,000.

Ind., Richmond—The Board of Public Works plans for the installation of a power house and refrigerating plant in the proposed two-story and basement municipal market and assembly building, 84 x 375 ft., estimated to cost $250,000. Werking & Son, American Trust & Savings Building, are architects.

Iowa, Edgewood—The Common Council has tentative plans under advisement for the installation of electric-operated pumping machinery at the proposed municipal sewerage disposal plant. W. E. Buell & Co., Davidson Building, Sioux City, Iowa, consulting engineers, are preparing plans.

Iowa, Marshalltown—The City Council plans for the installation of electric-operated pumping machinery at the proposed new waterworks station and system, estimated to cost $300,000, for which a bond issue will be arranged in the near future. O. G. Herm is city engineer.

Iowa, Oelwein—The City Council has rejected all bids received for the construction of an addition to the municipal sewerage disposal plant, with electric-operated pumping station, and auxiliary apparatus, and will call for new bids at an early date. Edward B. Tourtellot, Oelwein, is engineer; C. D. Shippy is city clerk.

Iowa, Villisca—The Common Council plans for the installation of electric-operated pumping machinery at the proposed municipal waterworks, estimated to cost $32,000. A special election has been called on Mar. 10, to vote bonds. W. J. Oviatt is city clerk.

Kan., Fort Leavenworth—The United States Army Department, Washington, D. C., has authorized alterations and improvements in the local steam turbine generating plant, for which bids will soon be called by the constructing quartermaster.

Kan., Fort Winfield Scott—The United States Army Department, Washington, D. C., has authorized the construction of a pumping plant on local site, for which bids will soon be asked by the constructing quartermaster.

Ky., Hichman—The Mengel Co., Eleventh Street, Louisville, Ky., manufacturer of wood boxes, etc., is said to be planning for the construction of a boiler plant in connection with the proposed rebuilding of its local veneer mill, recently destroyed by fire with loss estimated at $500,000, including equipment.

Ky., Lebanon—The Kentucky Utilities Co., Louisville, has acquired the local power plant and ice-manufacturing works of the Lebanon Light, Ice & Power Co., and contemplates extensions.

Ky., Shelbyville—The International Planters' Co-Operativ Redrying Co. has tentative plans for the rebuilding of its mechanical redrying works and boiler plant, recently partially destroyed by fire with loss of about $200,000.

La., Shreveport—The Southwestern Gas & Electric Co. is arranging an expansion and improvement program in plants and system for the present year requiring a fund of about $1,500,000.

Md., Baltimore—The Board of Trustees, Kelso Home, Louis Moller, president, 111 Light Street, has tentative plans under consideration for the construction of a power house at the institution. O. E. Adams, Equitable Building, is architect.

Md., Baltimore—The Curtis Bay Copper & Iron Works have filed plans for the construction of a one-story boiler house at their plant, 37 x 46 ft., at the end of Division Street, near Railroad Avenue.

Md., Baltimore—G. & L. M. Lang have filed plans for the construction of a one-story ice-manufacturing plant at 2858 Pennsylvania Avenue, to cost about $32,500.

Md., Jefferson Barracks—The United States Army Department, Washington, D. C., has approved plans for the installa-

tion of oil-burning equipment at the local power station, for which bids will soon be asked by the constructing quartermaster.

Md., Salisbury—The Peninsular Brick Co. is planning for the installation of a oil-operated engineer, about 100 hp.; air compressor, and other power equipment.

Mass., Andrews—The United States Army Department, Washington, D. C., has authorized the installation of coal-unloading equipment at Forts Andrews and Strong, for which bids will soon be asked by the constructing quartermaster.

Mass., Holyoke—The Municipal Gas and Electric Department has plans nearing completion for extensions and improvements in the municipal electric lighting plant, to include the installation of additional equipment. McClintock & Craig, 35 Lyman Street, Springfield, Mass., are engineers.

Mich., Wyandotte — The Mt. Carmel Parish, Tenth and Superior Streets, has had plans completed for the construction of a one-story boiler plant at the institution, 30 x 60 ft. John Finn & Son, 7720 Plymouth Road, Detroit, Mich., are architects and engineers.

Minn., Duluth—The Minnesota Power & Light Co., has completed plans for the construction of a new power plant in a neighboring township, estimated to cost $80,000. W. S. Robertson is vice-president and general manager.

Minn., Madison—The Village Council is planning for the purchase of a 250-hp. boiler and auxiliary equipment for municipal service. M. T. Hoff is village clerk.

Minn., Owatonna—The City Council is disposing of a bond issue of $350,000, the proceeds to be used for the construction of a municipal power plant, on which work will soon be commenced. C. J. Servatius is city clerk.

Minn., Red Lake Falls—The Red River Power Co., Grand Forks, N. D., is completing plans for the construction of a new power plant on local site, with cost reported in excess of $100,000.

Mo., Hartville—The Common Council is considering tentative plans for the construction of a municipal electric power plant. The local Commercial Club is interested in the project.

Mo., Lebanon—The City Council plans for the installation of electric-operated pumping machinery in connection with a proposed sewerage works to cost approximately $100,000. E. T. Archer & Co., New England Bank Building, Kansas City, Mo., are engineers.

Mo., Louisiana—The Louisiana Pure Ice & Supply Co., is having plans prepared for the construction of a new cold storage plant on local site. H. C. Reiff, East St. Louis, Ill., is engineer.

Mo., Preston—The Common Council is considering the installation of electric-operated pumping equipment in connection with a new water supply system.

Mo., St. Joseph—The St. Joseph Milk Producers' Association is planning for the installation of additional equipment at its plant, including boiler and auxiliary apparatus, 10-ton ice-making machine, cooling equipment, etc. L. Kleinschmidt is general manager.

Mo., St. Joseph—The St. Joseph Water Co. plans for the installation of electric-operated pumping equipment in connection with proposed plant extensions to cost in excess of $500,000.

Mo., Sedalia—The City Council plans for the installation of electric-operated pumping machienry in connection with extensions and improvements in the municipal water plant, estimated to cost $200,000. The Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., is engineer.

Mo., Siketon—The Common Council plans for the installation of electric-operated pumping machinery at its proposed local water supply and sewerage system. A special election to vote bonds will be held on March 1.

Mo., University City—A new grade school to cost about $100,000 will be erected in the Creveling tract by the School Board. The Terrell, Croft Engineering Co., St. Louis, Mo., has been retained to engineer the electric, heating and ventilating installations for the project.

Neb., Benkelman—The Common Council plans for the installation of electric-operated pumping equipment for its proposed new sewerage system, for which tentative plans are under consideration.

Neb., Crete—The City Council has called a special election on March 11, to vote bonds for $45,000, the proceeds to be used for the erection of a municipal power plant, for which plans will soon be drawn.. C. E. Beals is city clerk.

Neb., Kearney—Bonds for $135,000 have been voted for the installation of a municipal waterworks, to include the installation of electric-operated pumping machinery, semi-Diesel oil-driven engine, etc. The Common Council is having plans prepared by the Burns & McDonnell Engineering Co., Interstate Building, Kansas City, Mo., engineer. M. E. Burke is city clerk.

N. H., Bristol—The Utilities Power Co., Meredith, N. H., has superstructure work in progress on its proposed hydro-electric power plant on the Pemigwasset River, and plans for the early installation of machinery. The reported cost is in excess of $250,000. H. B. Rust is manager.

N. Y., Buffalo — The City Council has authorized alterations and improvements in the Ward pumping station, including pumping equipment.

N. Y., New York — The United States Army Department, Washington, D. C., has authorized the installation of an auxiliary boiler and subsidiary apparatus at the general intermediate depot, for which bids will soon be asked by the constructing quartermaster.

N. Y., Schenectady — The Adirondack Electric Power Corp., Schenectady, N. Y., has plans for the immediate construction of an addition to its local steam-operated generating plant.

N. Y., South Brooklyn—The Bureau of Supplies and Accounts, Navy Department, Washington, D. C., will take bids until March 4, for 25,000 pounds of boiler compound, as specified in Schedule 1902.

N. C., Durham—R. W. Rigsby, city manager, will receive bids until Feb. 28, for equipment for the municipal water plant, including three 725-hp. vertical hydraulic turbines; three 500-kw. generators; two 5,000-g.p.m. centrifugal pumps, arranged for turbine drive; two 260-hp. hydraulic turbines; two 5,000-g.p.m. centrifugal pumps, arranged for motor drive; motors, exciter, switchboard and auxiliary equipment, all as per specifications on file. William M. Piatt, Durham, is engineer.

N. C., Jefferson—The Common Council plans for the installation of an electric-operated pumping plant for the proposed new water and sewerage systems. H. C. Tucker is mayor.

N. C., Thomasville—The City Council is considering tentative plans for the installation of electric-operated pumping equipment in connection with a proposed water supply plant, estimated to cost $125,000. William C. Olsen, Raleigh, N. C., is engineer.

N. C., Vass—The Common Council is considering the installation of electric-operated pumping equipment in connection with a proposed waterworks. The J. B. McCrary Co., Atlanta, Ga., is engineer.

N. D., Salem—The Common Council is considering the installation of electric-operated pumping machinery at its proposed sewerage disposal works. H. L. Hintz is city clerk.

Ohio, Reading—The General Match Co., Cincinnati, Ohio, plans for the construction of a boiler plant at its proposed local works near the Reading Road, on which work will soon be commenced, estimated to cost $250,000, with equipment. The H. K. Ferguson Co., 4900 Euclid Avenue, Cleveland, is architect.

Okla., Harrah — The Oklahoma General Power Co., has construction under way on a local generating plant, designed for an initial capacity of 20,000 hp., and will commence the installation of equipment at an early date.

Okla., Shidler — The Common Council plans for the installation of an electric-operated pumping plant at the proposed new waterworks, estimated to cost $125,000. The Gantt-Baker Co., First National Bank Building, Oklahoma City, Okla., is consulting engineer.

Okla., Tulsa—The Public Service Co. of Oklahoma will commence the construction of superstructure for an addition to its ice-manufacturing plant on Eleventh Street, estimated to cost $35,000.

Ore., Albany—The Cameron Lumber Co., C. C. Cameron, manager, plans for the construction of a boiler plant at its proposed local mill, to be equipped for an output of 25,000 ft. per day.

Ore., Portland — The Portland Railway, Light & Power Co., has preliminary plans under advisement for the construction of a hydro-electric generating plant on the Clackamas River, with a capacity of 105,000 hp., estimated to cost $13,000,000.

Ore., Seaside—The Common Council plans for the installation of electric-operated pumping machinery for the proposed waterworks plant, estimated to cost $180,000. A bond issue is being arranged.

Pa., Philadelphia—The Philadelphia Electric Co. has filed plans for extensions and improvements in its power plant at Sixth and Federal Streets, to cost about $60,000.

Pa., Pittsburgh—The West Virginia Power & Transmission Co., 14 Wood Street, has received permission from the Federal Power Commission to construct and operate a hydro-electric generating plant on the Cheat River, West Virginia, on site about 1 mile below the Monongalia-Preston county line. The initial unit will cost more than $1,500,000. The company is a subsidiary of the West Penn Railways Co.

Pa., Silver Brook (Hazleton)—The Candlemas Coal Co. plans for the electrification of its operating plant, including the installation of electric-operated pumping equipment and accessory apparatus.

Tenn., Chattanooga—The Tennessee Paper Mills, Inc., has construction in progress on a new steam-operated power plant at its mills to cost approximately $80,000.

Tenn., Jackson—The Jackson Railway & Light Co. is planning for extensions and improvements in its steam-operated electric power plant to cost close to $100,000, with machinery. It is proposed to install additional water-tube boilers, generator and auxiliary equipment.

Tenn., Lawrenceburg.— The Common Council is arranging a special election, April 14, to vote bonds for a municipal hydro-electric power plant.

Tex., Elgin—The Elgin Ice & Cold Storage Co. will commence the immediate construction of a local ice-manufacturing plant. Robert Thompson, Taylor, Tex., heads the company.

Tex., Fort Sam Houston — The United States Army Department, Washington, D. C., has authorized the installation of oil-burning equipment at the local power house, for which bids will soon be asked by the constructing quartermaster.

Vt., Fort Ethan Allen—The United States Army Department, Washington, D. C., has authorized the installation of a boiler and auxiliary equipment in building E-17, for which bids will soon be asked by the constructing quartermaster.

Va., Alexandria—The Lamond Brick & Tile Co., Clarendon, Va., recently organized with a capital of $150,000, is considering the construction of a power house at its proposed local plant in the Potomac River, near Alexandria, estimated to cost $80,000. C. C. Lamond, Clarendon, is president.

Va., Gretna — The Gretna Roller Mills have inquiries out for a small generator and auxiliary equipment.

Va., Standardsville—The Greene County Creamery, Inc., is planning for the installation of a return-tubular boiler, engine and auxiliary equipment at its power house.

Wash, Wenatchee—The Columbia Ice & Cold Storage Co. is considering plans for the construction of an addition to its ice-manufacturing and cold-storage plant No. 2, Fifth Street, estimated to cost $100,000, with equipment.

Wash., Yakima—J. M. Perry & Co. have completed plans for the construction of an addition to their cold-storage plant, estimated to cost $37,000, with equipment.

W. Va., Arcola (Clarksburg)—The Smoot Lumber Co. has tentative plans for the rebuilding of the portion of its mill and steam power house, destroyed by fire, Feb. 11, with loss of about $50,000, including equipment. C. D. Howard is superintendent.

Wis., Chippewa Falls — The Board of Trustees, Chippewa County, Charles E. Preston, president, has plans under consideration for the construction of a new power house at the county asylum. It is proposed to select an architect at an early date.

Wis., Hurley—The Montreal Mining Co., a subsidiary of Oglebay, Norton & Co., Ironwood, Mich., will soon take bids for the construction of a new pumping plant, with installation to include two electric-operated centrifugal units, each with capacity of 200 g.p.m.

Wis., La Crosse—The Common Council is considering the electrification of the city pumping station, to include the installation of two centrifugal pumping units, with capacity of 4,000,000 gal. per 24 hours. The Northern States Power Co., is interested in the project.

Wyo., Cheyenne — The Cheyenne Light, Fuel & Power Co. has plans under consideration for extensions and improvements in its local steam-operated power plant, to cost approximately $50,000.